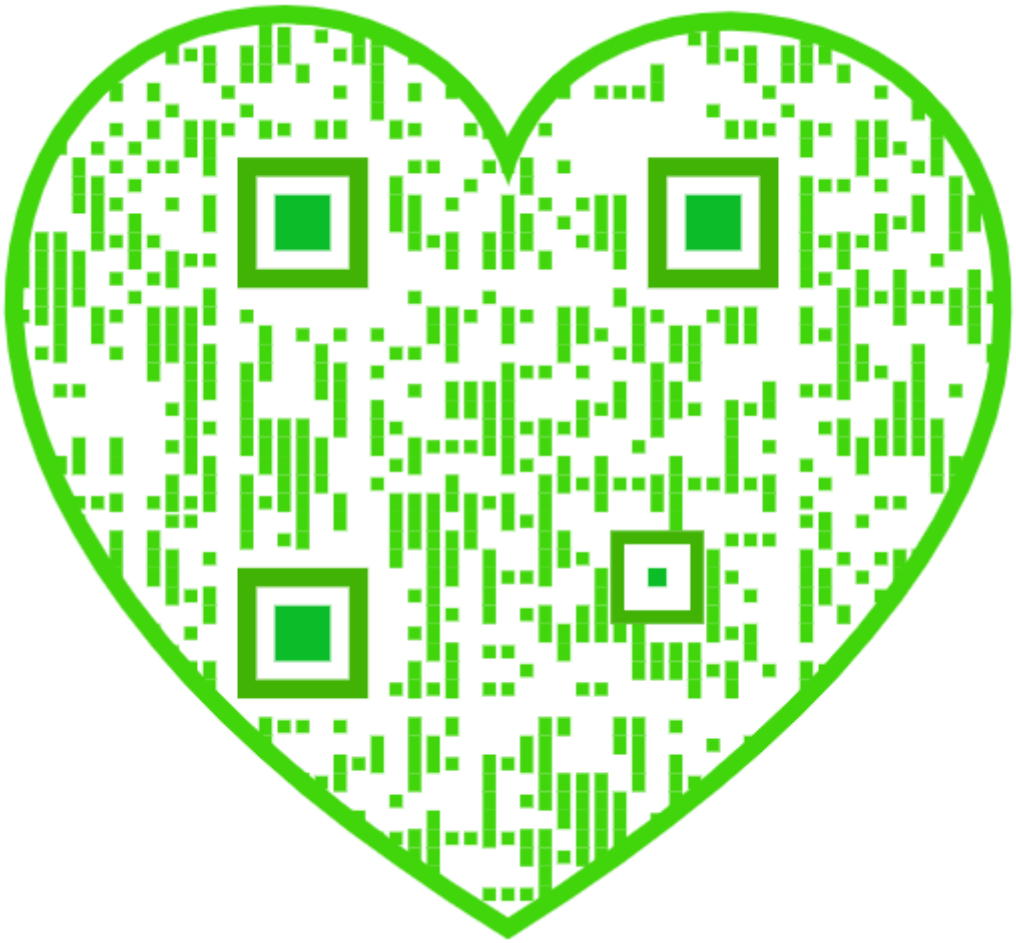

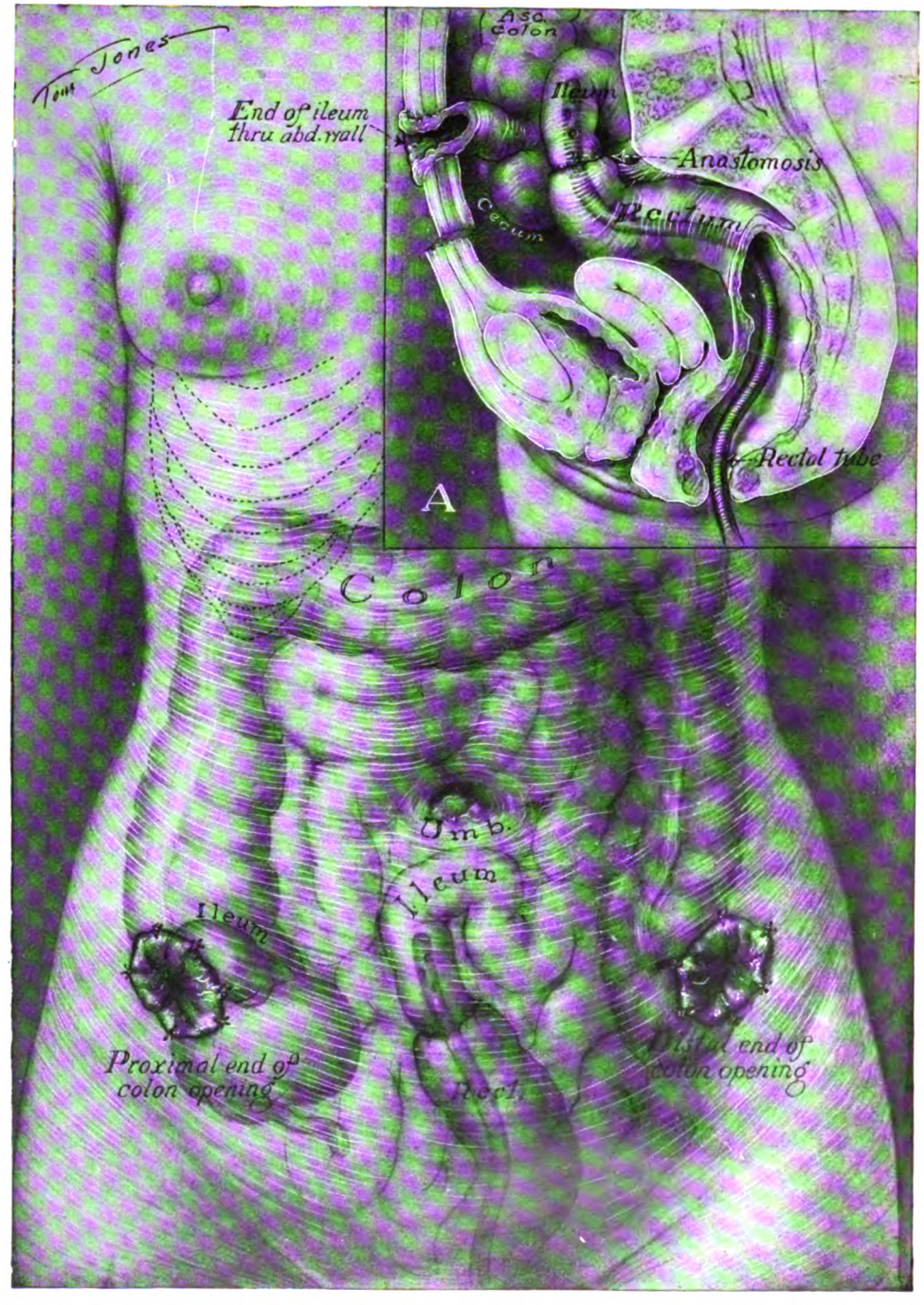
Tom Jones
End of ileum thru abd. wall
Asc. Colon
Ileum
Anastomosis
Rectum
Caecum
Rectal tube
A
Colon
Umb.
Ileum
Ileum
Proximal end of colon opening
Rect.
Distal end of colon opening

A NEW
MANUAL OF SURGERY
CIVIL AND MILITARY

BY

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SIXTH EDITION—REVISED AND ENLARGED

COMPLETE IN ONE VOLUME

FULLY ILLUSTRATED

CLEVELAND PRESS
CHICAGO

PREFACE TO THE SIXTH EDITION

The three years just past since the appearance of the fifth edition have again confirmed our experience of former years in that we have found the simplest methods with a minimum of trauma to the tissues to be the most efficient. All methods recommended have had our careful personal trial but none of them is original with us.

Local anesthesia with one-half percent. of novocain or its American equivalents has been employed in a large number of cases with excellent results; in fact almost every operation in the entire book has been performed with the use of this local anesthetic in cases in which ether anesthesia by the drop method seemed undesirable.

Dr. John Nuzum has given an accurate description of the use of this remedy which we have employed in almost all cases of thyroidectomy.

Dr. Erwin R. Schmidt has rewritten the section on brain surgery in keeping with the modern methods he is employing in our clinic in this especial field.

Radium and x-ray treatment has been employed under the counsel of Dr. Henry Schmitz who has contributed a chapter in this branch.

We wish to express our thanks to these colleagues as well as to Dr. Dennis R. W. Crile and Dr. O. E. Nadeau for much valuable assistance in bringing out this sixth edition.

A. J. O.
N. M. P.

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1920

PREFACE TO THE FIFTH EDITION

During the past two years, since the appearance of the very largely revised fourth edition, the changes in surgical practice have been confined to a large extent to the practice of military surgery, and it has seemed wise to add a considerable amount of material in a special chapter on this subject.

We have been able to still further confirm our former judgment regarding many methods which we saw fit to recommend in former editions. We especially wish to insist upon the fact that we make no claim in this or in any of the previous editions for originality or priority for any of the methods described, for all of which we are indebted to former authors of books or of articles in periodicals and to our personal observation of the surgical work of our friends in this country and abroad.

We especially wish to thank Dr. O. E. Nadeau for the great amount of assistance he has given us in the production of the present volume.

A. J. O.
N. M. P.

PREFACE TO THE FOURTH EDITION

The time that has passed since the publication of the third edition has been especially rich in our clinical experiences, both in our own surgical activity and in visits to other clinics in this country and abroad, which seems a reasonable basis for issuing a fourth, revised edition of this work. Assurance is given that changes have all been made after careful study and personal applications of the methods herein recommended.

As in each of the three former editions so also in this have we made perfectly plain which methods we have tried for a sufficient period to give a relatively final judgment, and which are still under observation.

There is no claim as to originality or priority for any of the methods herein described, neither is particular credit given to the originators for the reasons stated in the preface to the first edition.

We wish to acknowledge our indebtedness for assistance to our colleagues in the Augustana Hospital and especially to Drs. Frank Smithies, Ethan Allen Gray and Henry Schmitz for aid in their specialties.

A. J. O.
N. M. P.

PREFACE TO THE THIRD EDITION

For some time there has been a demand for a third edition of this work but until the present it has been impossible for us to give the necessary attention to make the careful revision which seemed indicated. During the interval since the publication of the second edition we have collected material constantly for this new edition. We have also had ample opportunity to test many of the newer methods and to confirm many of the old ones as we have kept careful records of more than fifteen thousand operations performed by us in this period.

Our methods have been adopted from many surgeons and adapted to our conditions. In many instances these surgeons have kindly furnished personal information and illustrations for which we wish to express sincere gratitude, as also for the inspiration and encouragement experienced through contact with these enthusiastic and tireless workers in the field of surgery.

A. J. O.
N. M. P.

PREFACE TO THE SECOND EDITION

In the preparation of the second edition the same general plan has been followed that was introduced in the first.

With increased experience in the use of operations which had not been fully tried, it has been possible to make some portions of the text more complete.

The additional material has, however, all been substantiated by my own clinical experience and can be depended upon in the same manner as the portion of the book which appeared originally.

In the chapter on stomach surgery an article by Dr. W. Mayo has been introduced in full because this covers the subject so perfectly that it would be impossible to improve upon it. I am again greatly indebted to this author for many valuable suggestions as well as for a number of most excellent original plates.

The text has been increased by about sixty pages, and the number of plates has been increased by nearly fifty per cent.

The views expressed concerning the treatment of certain forms of appendicitis, which differed materially from the generally accepted plan at the time of publication of the first edition, has been tried by hundreds of surgeons who have been able to follow the method carefully as described in this volume. Many of these have kindly informed me of the success they have obtained in this direction.

My own experience in the treatment of more than one thousand cases of appendicitis during the past three years has further confirmed the correctness of these views.

I wish to express my thanks to the many surgeons who have shown their appreciation of my efforts in the production of the first edition.

A. J. O.

PREFACE TO THE FIRST EDITION

Many practitioners who have honored the author by visiting his clinic have requested that a work on Clinical Surgery be written by him, giving as nearly as possible the methods adopted in actual practice. This request has been met by the statement that the author lays no claim to the invention of a single new operation, nor has he produced a new or modified instrument, but has contented himself with applying to his surgical work what seemed best in the practice of the surgeons of the past and present, many times without knowing by whom the various methods were modified before they were accepted and used by him.

This book is therefore offered for what it is worth under the limitations mentioned, the author being conscious of a certain incompleteness because of adhering closely to the intention of producing a work reflecting almost entirely the methods which have been thoroughly tried in his own practice.

In recommending certain steps the author does not desire to impress the fact that the method chosen or advised is the best, or the only good one, but rather that it stands as a means he has thoroughly tried and which can be reasonably relied upon. Whenever there is any doubt upon this point it is expressly so stated in the text.

There are necessarily some branches of clinical surgery in which the author's experience is limited, and it has seemed best to indicate this in the text in discussing the special subjects thus impaired.

Certain operations can obviously have no place in this volume, because they have been described in a given way by many writers for years, and would simply consume space for reiteration without increasing the value of the work. I refer especially to the typical ligations, amputations and the resection of joints.

A portion of this work deals with clinical cases taken from hospital records and discussed as one discusses such cases in practice. This has been done for the purpose of bringing the actual clinical conditions before the mind of the reader. It did not seem wise to carry this plan through the subjects in which it was possible to bring out the salient points in more concentrated manner. In order to impress the reader with the cardinal facts upon which success in the treatment of various conditions depends, many unimportant

and useless matters have been intentionally omitted. This undoubtedly reduces the scientific merit of the book, but it has appeared to the author to increase its practical value.

No reference is made to authors whose methods are described, because most of the procedures set forth were not used in their original form, having been repeatedly modified, usually by a number of operators. In order to give each one the due amount of credit deserved the work would have grown far beyond the designated limits. An exception is made in those cases in which the original drawings of writers are employed. The author is indebted to all of his friends in the surgical profession whose methods he has adopted, and hopes that where they find familiar details they will appreciate the gratitude he bears toward them for having markedly assisted in the improvement of his technique.

All drawings herein are original, having been made by Miss Alice L. Cleaveland for this volume from immediate operations, with the exception of a few which were taken from original publications of other authors; the latter are especially designated in their accompanying text.

The author is particularly indebted to his friend, Dr. W. J. Mayo, for many valuable suggestions, and to his brother, Dr. E. H. Ochsner, and his chief assistant, Dr. Nelson M. Percy, for relieving him of many burdens incident to the production of a book.

Finally, it should be said that this work is not written for the great surgeon, or the teacher of surgery, whose methods are as well tried as those contained in this volume, and undoubtedly quite as useful, but rather for the man who is compelled, by virtue of the circumstances surrounding him, to do surgery, and who wishes to know what the author would do in a similar case to the one he happens to have under treatment at any given time. He may be familiar with many methods, but at the same time may wish to know which one has seemed most satisfactory to the author.

A. J. O.

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PART I

GENERAL SURGICAL CONSIDERATIONS

EXAMINATION OF THE PATIENT

The benefits of clinical surgery cannot be realized to the fullest extent without considering the patient himself, aside from the disease for the cure of which he seeks surgical treatment. Much of the surgeon's success depends upon the value of his judgment and knowledge outside of his especial line of work. Many patients may live in relative comfort for a considerable period of time whose lives otherwise may be cut short by an attempt to obtain complete relief. On the other hand, many patients may, with the same degree of safety, obtain complete, rather than partial relief, as a result of the excellence of the surgeon's judgment.

Clinical experience of the surgeon. To excel to the fullest extent, the surgeon requires not only the necessary knowledge to make the proper diagnosis, and technical skill to perform the necessary operation, but he must also have an extensive clinical experience which can fortunately be obtained, in this country at least, in service as assistant to those who possess this experience, particularly in the great number of excellent hospitals which have been established in most of the larger cities.

General examination of the patient. In order to be able to judge of the patient's condition, aside from the particular ailment from which he is suffering, it is necessary in each case to make a careful general examination. This should include a physical examination of the head, neck and chest, the abdomen, the nervous system; a chemical examination of the urine, and at least an observation of the character of the fæces. In many cases the blood should be examined, and if there is cough the sputum should be examined.

Diagnostic section of tumors condemned. In making an examination we should, however, be exceedingly careful not to fall into the opposite error of making a diagnosis without regard to the patient. We have repeatedly seen patients lose their lives because of the fact that the surgeon felt it his duty to make a positive diagnosis. This is especially true of cases in which portions of safely-removable tumors were excised, previous to their total removal, for microscopic examination for the purpose of making a positive diagnosis. In these instances we have frequently seen metastases appear very soon after this apparently unimportant preliminary diagnostic operation was performed, which were probably due to the excision of the small portion. We believe this should be very strongly condemned, because the removal of a benign tumor is in reality a harmless performance compared with the dissemination of a malignant growth. There are but few exceptions to this rule, chiefly in bone tumors in which the treatment of a malignant growth would necessitate an amputation, while a benign tumor can safely be removed from the implicated bone. In case a portion of a tumor is removed for the purpose of making a diagnosis this should invariably be done by means of the actual cautery or the electric cautery. The microscopic examination should

always be made immediately from frozen sections and in case of any doubt still remaining a radical removal should be made at once. In case the gross appearance indicates the presence of malignancy which the microscopic examination fails to confirm the matter should be disregarded.

Diagnostic palpation of tumors condemned. In connection with the diagnosis of malignant tumors we would also caution, very emphatically, against applying much pressure to the surfaces of these growths. We have observed many a case of carcinoma of the breast, for instance, which had remained almost stationary for many months until the patient began to have it examined. Each successive examining physician, and all the patient's friends, had thoroughly massaged the growth during repeated examinations and it seems reasonable to suppose that in this way the rapid increase in growth, the involvement of the lymphatic glands, and possibly the metastasis in the liver could be explained, because of the likelihood of forcing cells from the primary growth into the lymph channels.

In the same manner, we have observed that patients suffering from septic infections of the extremities regularly show a rise in temperature after a thorough examination, during which every effort was made to locate points of fluctuation.

It seems reasonable, therefore, to condemn what might be called diagnostic massage, at least in all patients suffering from malignant growths and septic infections.

Exploring syringe condemned. The exploring syringe is an instrument which is also responsible for much harm, because in many cases in which pus has been diagnosed positively without this instrument, the syringe, instead of confirming the diagnosis, shows negative results, on account of some obstruction in the lumen of the exploring cannula used.

In a number of instances we have seen great accumulations of pus removed from empyemata and other abscesses after repeated tests with the exploring syringe had resulted negatively. This is frequently the case, even when a needle with large caliber is used. Many an abscess has remained unopened because the exploring needle was supposed to afford a positive test.

In other cases extensive and serious infections have been caused by the use of the exploring syringe because the great pressure under which the pus was confined in the abscess has forced it into the surrounding tissues or cavities along the puncture made by the exploring needle.

In exploring the brain for the location of an abscess it is sometimes necessary to use an exploring syringe with a large cannula—it may also be useful in differentiating between pleurisy with effusion and empyema—but aside from this we believe that its use should be discarded.

All that has been said against the use of the exploring syringe can be uttered with much greater emphasis against an instrument which has fortunately been almost entirely discarded, namely, the grooved exploring needle. This instrument possesses all of the bad qualities of the exploring syringe to an exaggerated extent, without having any of its good qualities.

If it seems advisable to make use of an exploring syringe in a given case it should be armed with a trocar of the desired size instead of the ordinary aspirating needle, as the former is much less likely to be obstructed and is therefore more certain to give the desired information.

The personal element of risk in operations. In considering the patient in relation to the advisability of an operation, it will be found that in a large majority of cases there is scarcely any doubt regarding his ability to bear the operation itself, barring accidents; but this fact should not lead us to

take for granted that this will be the case in any individual case without having taken pains to make sure. With experience one learns to place certain cases in the class of good risks and others in the class of bad risks, with many intermediate grades; and it is not an easy matter to classify these cases so that one who has not actually come in contact with them can appreciate their difference even with a very minute description.

We would class among the good risks patients who are nearly normal as regards all the organs of the body, with the exception of the part involved in the disease for which the operation is to be performed; if the disease is not located within or near an important organ; and provided that the operation is not to be done for the relief of a disease due to an acute infection. If the operation is to be performed for the relief of an acute infection, then the risk will depend upon the question,—Can the progress of this infection surely be checked by the operation?

It seems that an acute infection does not respect natural strength or endurance. We have here, however, quite a safe guide in the condition of the pulse. An operation performed upon a patient with a pulse of over 120 beats per minute must always be looked upon as serious, and with a pulse still higher the gravity of the condition increases rapidly. If the operation will remove the existing septic material and at the same time make a further infection impossible, or at least unlikely, then it must be looked upon as being relatively safe.

Old age of itself not a contraindication to surgical operations. Among the conditions almost always enumerated as contra-indicating serious operations is old age. There are certain very good reasons for this. A person who has lived many years has had relatively more opportunity to impair his various organs than one who has lived a shorter time. Moreover, his tissues are in themselves old, and especially his blood-vessels have lost much of their elasticity. On the other hand, we must bear in mind that the fact that these persons have attained great age would indicate that they were primarily well made, or that their normal resources have been well preserved.

As a matter of experience, we would state that in the absence of obesity, myocarditis, arterio-sclerosis, nephritis, marked anemia, or cachexia, due to the presence of malignant growths, patients advanced in years bear surgical operations well, if they are permitted to move about and sit up soon after the operation. (This allowance rarely interferes with the recovery after any operation, provided we bear this in mind in the suturing of the wound and in applying the dressings.)

Confinement to be avoided. To one whose attention had not been directed to this peculiarity of patients advanced in years it might seem foolhardy to permit the patient to sit up on the day following so serious an operation as a herniotomy, abdominal section or an amputation of the breast with removal of the pectoralis major and minor muscles and the axillary fat and lymph glands, but experience leads us to say that in operations as severe even as these, the course mentioned is strongly to be advised.

Lowered resistance from "high" life. There is one element which it is well to bear in mind in connection with the consideration of old age in surgery. Many times patients not much over forty years of age, whose lives since adolescence have been spent under conditions of severe mental tension, so common among business and professional men in the larger centers of population at the present time, show a degree of senility, so far as their nervous and vascular systems are concerned, which indicates that they should be classed with those who are in reality from twenty to thirty years older. In

these patients one encounters a high degree of arterial tension, an erratic, nervous heart, and there is usually a deficiency in the excretion of urea. This general condition is much more common among men than among women, because men are more constantly exposed to nervous and mental strain than women, with the possible exception of the small and useless class known as "society" women, which is so unimportant as not to require attention save to point the contrast. This condition of instability is undoubtedly exaggerated by the poisonous effects of nicotin and alcohol, which serve so well as temporary stimulants in relieving the immediate distress of mental and nervous strain to which these professional and business men are exposed.

In these cases thorough elimination by the use of very little easily digestible food, the taking of large quantities of good water, the gradual reduction in the use of tobacco and abstinence from alcohol are strongly indicated.

Fresh buttermilk seems to be especially useful both as a food and as an eliminant in these cases. Castor oil given in two-ounce doses in the foam of beer or ale, or the extract of malt, aids greatly in improving the condition of this class of patients. The use of continuous proctoclysis under low pressure or by the drop method following operation is especially valuable in this class because by favoring elimination proctoclysis greatly relieves the circulatory system.

These patients should never be exposed to long-continued operations, and they are especially bad subjects for nitrous-oxide-gas anesthesia, because of its effects in increasing the blood pressure.

Erratic cases. Many cases do badly after operations without showing definite symptoms of sepsis or complications pointing to disease of the kidneys, heart or lungs, although all of these organs may be under suspicion. There may be too small an amount of urine secreted, suggesting the likelihood of acute renal congestion, causing a fear of impending uremia, or the heart's action may be somewhat erratic or weak, causing one to fear that a myocarditis may have been overlooked. Again, there may be accelerated respiration indicating the possibility of an incipient pneumonia, or these conditions may exist simultaneously with or without beginning sepsis.

In our own experience it has seemed as though one can usually anticipate this condition by a careful preliminary examination, together with a careful consideration of the patient's history, and especially that part of the history which relates to the habits of life, particularly as regards nervous strain and rest and the use of alcohol, tobacco and drugs; also the consideration of the quantity and quality of food accustomed to.

On the other hand the patient can often be protected from danger by a preliminary course of hygienic living, especially where there is no great urgency, and the operation is for chronic conditions.

Laxatives before operations. We have used various forms of cathartics previous to operations at different times, but have now come to depend on but one cathartic before operation in all cases in which there is present no form of peritonitis or intestinal obstruction. In the latter classes of cases any form of cathartics or laxatives should be condemned most vigorously. In all others two ounces of castor oil are given to adult patients, one-half this dose to children from four to twelve years of age, and proportionately less to younger children and infants.

High blood pressure. The matter of abnormally or excessively high blood pressure does not have to be considered in patients less than thirty-five years of age, and only in rare instances in patients less than fifty-five years of age. It should, however, be borne in mind that it is in fairly young

patients that one is most likely to get into difficulties from this cause, because it is much easier to overlook this source of danger in the relatively young patient than in those more advanced in years.

Operations in two or more stages. Many of these patients will bear an operation which involves only a small amount of trauma without any difficulty, while they succumb to extensive operations in which they are subjected to the influence of anesthetics for a considerable period of time. In such cases the nervous strain accompanying local anesthesia is also borne very badly, consequently, there is not much choice between these two evils. It is, however, often possible to perform these operations in two or more stages. If such a patient, for instance, has a uterine tumor and gall stones, or a hernia and some other pathological condition, or any two of any number of other combinations, it is best to perform one of these operations at a time. In intracranial affections, for instance, it is better to make a temporary skin and bone flap, control the hemorrhage, carefully replace the flaps and complete the operation when the patient's condition has been thoroughly restored.

It is not necessary to go into details at this point, the general principle involved simply contemplates a plan by which as small a burden as possible is placed upon a patient who is not in a good condition to carry additional burdens. These patients usually bear repeated light burdens better than single heavy ones.

Infants bear operations well. The same seems to be true of the other extreme in age. Infants bear operations well, provided they are not too long continued, nor accompanied by too great loss of blood.

Guard against hemorrhage. The mortality in infants following operations is due largely to shock caused by the trauma of the operation and the hemorrhage. It is important to remember that an amount of trauma which would not have to be considered in adults because of the size of the patient and the consistency of the tissues, may result in serious shock in infants and young children. Again, the same amount of blood lost by a child weighing fifteen pounds is ten times as serious as a like amount lost by an adult weighing one hundred and fifty pounds.

Operate rapidly. A surgeon who is slow and violent in his manipulations should therefore choose only adult patients. Operations upon infants should be carefully planned, quickly executed, and with the least possible amount of trauma and the smallest possible loss of blood.

Quite a few children and infants die after operation from pneumonia. This can, however, be almost completely avoided by reducing the time of operation to a minimum, by permitting the child to almost completely come out of the state of anesthesia by the time the operation is finished, and by applying the sutures so that the patient can move about freely, and if possible to sit up in bed, soon after the operation has been terminated.

Protection of the mother in the after-care of infants. In nurslings it is, moreover, most important to secure the co-operation of the mother. The latter should never be permitted to undertake the care of the infant after a serious operation, because the resulting fatigue and anxiety will surely have a harmful effect upon the milk, and the child will consequently suffer from gastric disturbances in addition to those naturally resulting from the effects of the operation.

These conditions should be carefully explained to the mother so that her natural anxiety for the safety of her child will serve to improve its prognosis rather than to reduce its chances. In many instances we have seen a worn-out mother improve remarkably in health during the time her

child has been confined to the hospital, and with the improvement of her general condition the child's nutrition is always greatly bettered. The mother should not live in the hospital, but conveniently near so that she can come to the hospital at regular intervals, varying from three to four hours, according to the age and condition of the child.

It is well for the mother to have a definite program which she must follow absolutely. She should never be permitted to carry or hold the child except while actually nursing it. Before she nurses the child the first time in the morning she should drink a pint of hot milk or gruel so that she will not be in a depressed state during the act of nursing. After nursing the child she may take a walk in the open air, then breakfast liberally, then rest for at least one hour and return to the child just in time for the next feeding. Her luncheon is again followed by a period of rest. In the middle of the afternoon the mother may take some nourishment, preferably a pint of milk, with bread. She may take a liberal meal in the evening, nursing the child at regular intervals varying from two to four hours according to the requirements of the little patient, the time of nursing being so arranged that the mother can obtain from seven to ten hours of uninterrupted sleep. She should always take some nourishment before retiring. Both the mother and the child will form regular habits during the time the latter is in the hospital and the health of the former, and the nutrition of the latter invariably improve to a marked extent under these circumstances.

Importance of safeguarding blood supply. For all patients it is wise to guard against the loss of an unnecessary amount of blood; but this is especially true in children and in those advanced in years, because many of these do not recover readily from an anemia caused by a great exsanguination. Every operation should be carefully planned with the idea of preventing the unnecessary loss of blood. Usually this end can be accomplished if the surgeon lays out a thoroughly systematic course for his operation, because the source of hemorrhage in every operation can be anticipated by applying two pair of forceps to each one of the larger vessels before it is severed, and quickly applying clamps to the oozing surfaces as the operation progresses, in all parts of the body in which it is not possible to entirely prevent hemorrhage during operation by the application of elastic constriction. If the surgeon has assistants who have learned how to concentrate their attention during the progress of the work, much is gained in saving blood because they will anticipate the surgeon and will stop all hemorrhage almost instantly at those points in which one cannot apply forceps before severing the tissues.

Slow vs. rapid operating. There are two errors which will be referred to again presently which the surgeon should not fall into in his attempts to prevent loss of blood, namely: too rapid and too slow operating. The former is certain to lead to calamity occasionally in individual cases, although the majority of patients will undoubtedly do well under very rapid technique. The slow operation is especially likely to result in secondary post-operative complications such as pneumonia and nephritis.

It is important to take a reasonable attitude regarding this feature. It is possible to be guilty of insane haste on one side and of imbecile deliberation on the other.

OBESITY

Special care required. Patients who are very obese, especially those beyond middle age, require particular consideration. Their resistance is diminished;

they recover from shock less speedily; they frequently take the anesthetic badly; and they are more liable to pneumonia following the use of ether than patients with a normal amount of fat. Still it is only seldom that the presence of obesity will contra-indicate an operation entirely. Ordinarily it would simply indicate the use of especial care.

In many of these patients it is possible to reduce the weight to a great extent before operation by following a systematic plan of dieting, combined with exercise and baths.

Anti-Obesity Diet. There are three breakfasts, three luncheons and three suppers; any one of which you may choose, but you must never eat more than is contained in any one of these meals. In place of any one of these meals at any time you may substitute one pint of buttermilk if you like.

In addition to any one of these meals you may take one of the following articles but nothing more: 1 orange, ½ grape fruit without sugar, one baked apple without sugar, one dish of spinach, one dish of head lettuce with pepper, salt and lemon juice but no oil.

Breakfast.—No. 1. One or two soft-boiled eggs, one small piece of toast. No. 2. Half a pound of lean steak, one baked apple. No. 3. Half a pint of hot milk and one small piece of bread.

Luncheon.—No. 1. Half a pint of soup and one small piece of bread. No. 2. Half a pound of fresh fish broiled, one dish of lettuce with pepper, salt and lemon juice. No. 3. One pint of buttermilk and one small piece of bread.

Supper.—No. 1. Half a pound of beef, one dish of spinach or one dish of turnips or one dish of boiled onions. No. 2. Half a pound of lean mutton, one dish of cabbage or one dish of cauliflower or of squash. No. 3. Half a breast of chicken, one dish of lettuce with pepper, salt and lemon juice, or fruits cooked without sugar, or one dish of cooked vegetables or one glass of fruit juice. Aside from the above the patient may eat grape fruit or oranges if he desires in connection with any meal.

You should drink nothing at all during your meals nor for one hour before or after eating. No water, tea, coffee or fluids of any kind. Between meals you may drink a small amount of water, either hot or cold, flavored with lemon or orange juice. Take absolutely nothing containing alcohol.

Take breathing exercises regularly morning and evening. Take a walk out of doors every day. Increase the length of your walk gradually and also the speed.

In planning the operation in these cases the wound should be so sutured that the patient can move about freely in bed and if possible sit up directly afterwards, especially for the purpose of preventing hypostatic pulmonary congestion following operation. In most of these cases it is well to elevate the head of the bed from four to eighteen inches.

TUBERCULOSIS

General operations inadvisable. In patients suffering from tuberculosis an operation is usually borne well if it removes the tubercular tissue. If this is not removed by the operation such patients frequently do not do well. Consequently the presence of tuberculosis is only a contra-indication to operation in a limited variety of cases. In patients suffering from pulmonary tuberculosis long-continued operations are contra-indicated chiefly because the disease in the lungs is likely to make progress during the time that the patient is recovering from the depressing effects of the operation.

It is difficult to say whether ether anesthesia is really in itself harmful

in these cases. It has been suggested that anesthesia by inhalation be not employed in such instances and that local, spinal or rectal anesthesia be substituted in all cases in which pulmonary tuberculosis is present.

Preliminary general treatment. It is generally possible to place these patients under preliminary hygienic, dietetic and often under climatic treatment for the cure of the pulmonary tuberculosis before they are subjected to surgical operations. In many the local condition, if it is also due to tuberculosis without mixed infection, will recover simultaneously with the pulmonary tuberculosis. This is true especially in cases suffering from joint tuberculosis in which perfect immobilization has been accomplished while the pulmonary condition is under the above form of treatment.

Surgical relief in the tuberculous. Many of the older surgeons have noted the fact that patients suffering simultaneously from a mild form of pulmonary tuberculosis improved rapidly after operations removing extremities containing a tuberculous joint, as for instance an amputation of the hand in case of tuberculosis of the wrist, or amputation through the lower third of the thigh in case of tuberculosis of the knee. On the other hand they found that similar cases became worse rapidly and resulted fatally in a short time in those in which an attempt at excision of the joint was practised. Later on when these latter operations were performed under antiseptic precautions if they healed primarily the pulmonary condition usually improved rapidly, while if they suppurated the opposite was true.

Dr. Emil Beck has given a very ingenious explanation for these facts. He supposed that in every patient suffering from tuberculosis there is an attempt by nature to provide a sufficient amount of antitoxin, that the tuberculosis tissue removed by amputation leaves more of the substance in the blood to combat the disease in the lungs and elsewhere, and that for this reason healing occurs. On the other hand if the organism is burdened by any additional task, as for instance the combating of a mixed infection, the balance changes in favor of the disease and the patient succumbs to pulmonary tuberculosis. The shock of a long-continued bloody operation would undoubtedly have the same effect.

CACHEXIA DUE TO MALIGNANT GROWTHS

A contraindication. Ordinarily the presence of cachexia in patients suffering from malignant growths is a distinct contra-indication to operation, because these patients do not bear operations well and with few exceptions derive very little benefit therefrom. This is, however, not the case in ulcerating carcinoma in which the cachexia is due largely to the absorption of products of decomposition, which can often be safely eliminated by an operation.

Again, in cases in which the malignant growth interferes with nutrition by obstructing some portion of the alimentary canal this rule does not always hold good, because frequently the improved nutrition greatly overbalances the traumatism resulting from the operation.

In a general way it may be stated that so long as the condition in a given case seems to indicate the possibility of removal of all of the malignant tissue the operation is warranted provided it does not necessitate the removal of a part of the body which is necessary for the continuance of life. In some cases the apparent cachexia can be removed before operation by appropriate treatment.

Example: gastric carcinoma. In cases of carcinoma of the stomach, for instance, the patient frequently absorbs a quantity of decomposing substance

during a considerable period of time, and as a result of this his condition becomes markedly cachectic. In many such the tumor may still be confined to the stomach. If operated at once the resistance of the patient may be so low on account of the condition described above that he may succumb to the shock of the operation. If the same patient has gastric lavage performed three times daily at intervals of eight hours, or four times daily at intervals of six hours, two hours after receiving some concentrated sterile food, his condition will improve to a surprising extent in from one to two weeks.

The ingestion of small doses of oil of eucalyptus, from five to twenty drops after each gastric lavage, is of further aid in the disinfection of the stomach cavity. In the meantime the patient's strength can be further supported by giving rectal feeding in the form of one ounce of some one of the various concentrated liquid predigested foods in the market dissolved in three ounces of normal salt solution, administered slowly as an enema through a small rubber catheter introduced into the rectum for a distance of not more than three inches.

One danger in preliminary treatment. One danger must be borne in mind in connection with this form of preliminary treatment. In many instances the general welfare improves to so marked an extent that some doubt may arise concerning the original diagnosis, and this may occasion postponement of the operation until the carcinoma has advanced to a hopeless point. It is always bad practice to postpone operations of any kind in patients suffering from malignant growths, because after such a growth has once begun to invade the surrounding tissues there is no stopping of its progress except by its complete removal or by the death of the patient, hence the importance of not losing valuable time before an attempt is made to remove the growth.

During the time that the patient is under observation prior to operation it is well to administer from 500 to 1,000 cc. of normal salt solution, by means of Murphy's proctoclysis, from four to six times each day. It is well to add to each application from 30 to 60 cc. of one of the various recognized concentrated liquid foods. The use of this proctoclysis has a tendency to fill the blood vessels and to greatly improve the resistance of the parts.

Blood transfusion may be employed previous to operation in these cases. It is often of great value in preparing cachectic and anemic patients for operation. The technique is described elsewhere.

SPEEDINESS IN OPERATING

Two viewpoints. The question of time is of sufficient importance to demand some consideration. It is only necessary to look upon an operation from the two sides which have a bearing in order to come to a proper estimation of the importance of this element: 1, from the merely mechanical or technical point of view, and, 2, from the point of applying this to the patient.

From the technical standpoint it is plain that a skilled mechanic not only does his work well, but accomplishes it in a relatively short time, while one unskilled will have much less satisfactory results by taking a much longer time; skill, accuracy and facility naturally going hand in hand in bringing about the highest possible outcome.

Careful haste. However, a hasty mechanic may complete a badly-constructed product in a relatively short period of time; and it is consequently necessary, from a purely technical standpoint, to distinguish clearly between speed which is the result of skill and dexterity, and speed resulting from

carelessness, wanton haste and lack of thoroughness. From a strictly technical standpoint, then, we have a right to demand the greatest speed compatible with careful, thorough work. When we come to apply this directly to the patient still further elements will be introduced.

Hasty and careless work is more harmful because of the needless traumatism which it is likely to produce, and this may in turn result in shock or in the injury of structures needlessly implicated. The patient may not receive the full amount of benefit through lack of thoroughness, some conditions being overlooked and neglected on account of undue haste.

Dangers of slowness. On the other hand, it is almost equally bad to prolong an operation needlessly, because this exposes the patient to a number of unnecessary dangers: 1, A prolonged anesthesia increases the danger immediately, and many times the patients will recover from a short anesthesia with scarcely any discomfort, while they will suffer greatly from nausea and vomiting after a prolonged anesthesia. If ether is employed, a prolonged anesthesia is much more likely to be followed by bronchitis or pneumonia than a short one. 2, Other things being equal, the amount of shock is proportionate to the relative time consumed in the operation. 3, Infection is more likely to occur in a wound which has been exposed to manipulations for a long time.

Local anesthesia favors deliberateness. In operations performed under local or spinal anesthesia the element of time is of course very much less important than with general anesthesia, provided the operation is completed before the local anesthetic has lost its effect, because the condition of the nerves in the field of operation prevents shock from long continued manipulations and there is no danger from postoperative pneumonia unless the patient has been unnecessarily exposed to cold or moisture. Of course, if the patient has been chilled during the operation, this may give rise to shock and pneumonia may occur.

Reasonable speed in operating. Then again, there are many cases in which the element of time is of no real importance because the procedures are so simple, and some patients are so vigorous that they will recover even if they are not given the best possible conditions. It seems, however, reasonable to demand of the surgeon a fair amount of technical skill and dexterity, especially as there are instances in which the lack of these might cause the death of the patient. It seems foolish to hurry, and equally so to prolong an operation unnecessarily.

There are two tendencies which become quite prominent in some hospitals and clinics which we believe should be abandoned, one of these might be characterized as insane haste in performing operations and the other as imbecile deliberation. It is difficult to say which of these is the more reprehensible.

Of course, it is not possible for all surgeons to work at a given rate of speed, but every surgeon should strive to waste no time and without hurry to complete each operation in the shortest period compatible with thoroughness. Both careless handling of tissues in order to gain speed and useless manipulation while wasting time should be avoided.

In extreme cases where the time element is of paramount importance considerable time may be saved, in abdominal cases, by closing the wound with silkworm-gut sutures through all the layers, and placed at least as close as 1½ cm. apart.

TRAUMATISM

Importance of reducing injury. There can be no doubt of the importance to the patient of reducing the traumatism incident to surgical operations to a minimum. Even though the patient be asleep, and consequently not conscious of the traumatism, the amount of injury done to his tissues is a definite burden placed upon him, and the less this burden is the better for the patient. In order to obtain this minimum of traumatism the conditions in each case must be studied separately and the operation planned accordingly. It is often possible to accomplish the same result through a small rather than through a large incision, which will reduce the amount of traumatism; in other cases it would require much crushing of the tissues in a small wound while the same operation could be accomplished through a large wound without this added injury.

Above all things a surgeon should form the habit never to manipulate tissues needlessly and especially not to manipulate organs which are not involved and which may readily be left untouched.

The typical operation. In many instances much traumatism is caused by the surgeon for the purpose of securing an absolute repair of a given lesion, which if left to itself would heal spontaneously with a better result and at less expense to the powers of the patient. This is true especially of the newer operations, which are usually quite complicated. One by one the useless elements of such an operation are eliminated, and with this progress much of the traumatism is discarded. And this statement is also true not only of the individual surgeon who naturally accomplishes any given operation with less traumatism after he has performed it repeatedly, than during his first attempts, but there is always developed in time what might be termed a fairly normal or typical operation from which experience eliminates most of the useless and practically all of the harmful features. Those who have been actively engaged in surgical work from the beginning of the antiseptic era to the present time have had an excellent opportunity to observe this process of evolution in surgical technique in connection with most of the operations which have attained an established position in the field of clinical surgery.

In a general way it seems proper to state axiomatically that violent surgery is bad surgery.

Standardized efficiency. At the present time all productive manual work in the various manufacturing industries is subjected to careful study by experts for the purpose of determining the highest possible degree of efficiency. This is accomplished by systematic motion study by means of which it is possible to eliminate unnecessary motions. This plan has been applied to a slight extent to surgical work with the result that it has been shown that the practical surgeon stands at the bottom of the scale of skilled workmen. It is clear that it is our duty to correct this defect because in this way the margin of safety can be enormously widened in serious surgical cases and the comfort can be correspondingly increased in those that are less serious but equally difficult. Both teachers and practitioners of surgery should give this feature the study and attention it deserves. In the manufacturing industries it has been shown that by this study the poor or indifferent workman can in this way much more easily approach the efficiency

of the really excellent workman and there is no reason why the same results should not be obtained in surgery.

HEMORRHAGE

Apply hemostasis at once. Except in especially anemic patients a moderate amount of blood can be lost during an operation without causing appreciable harm, but it is well to limit the amount by quickly applying hemostatic forceps to all bleeding points the moment the incision is made, and to grasp the larger vessels, whenever possible, between two pairs of forceps before they are severed; in all operations upon the extremities to elevate the latter for several minutes and then to constrict them above the area of operation with a large rubber tube or a broad rubber band drawn about the part a number of times and tied. If the extremities are constricted in a careless manner severe harm may be done especially to the nerve trunks. It is wise always to surround the part with a towel folded upon itself about four times and then to use a soft rubber drainage tube at least one inch in diameter as a constrictor.

The pneumatic constrictor. Recently a number of contrivances have been introduced which are intended to accomplish complete constriction of the blood vessels without endangering the nerves. One of the best of these consists of an adjustable pneumatic tube which is applied about the extremity at the desired point and adjusted. It is then inflated with air to the degree necessary to completely obstruct the flow of blood both in the arteries and veins. The same apparatus can be utilized in the application of Bier's local congestion treatment to be discussed later. It is plain that no harm can be done to the nerves in an extremity exposed to the pressure from such a pneumatic constrictor.

Hemostatic forceps and clamps. It is usually not difficult to reduce the loss of blood to a very small amount without consuming a great deal of time. If strong hemostatic forceps are used the ends of the blood vessels will be crushed sufficiently to make a ligation of all the smaller vessels unnecessary. It is well to leave the forceps in place until the operation has been completed, then to ligate the larger vessels and simply to remove the forceps from the smaller ones.

Various hemostatic clamps have been invented for the purpose of controlling the hemorrhage during and after operation without the use of ligatures, and it is well to bear this feature in mind in purchasing such clamps, because the use of effective instruments of this kind will reduce the time of operation quite sufficiently to merit attention.

Ligatures preferable to torsion or crushing. A number of years ago the use of these clamps seemed especially indicated because ligature material was not generally reliable. This is no longer the case as catgut can now be easily prepared according to methods to be described later so that it is absolutely safe. For this reason it seems unnecessary at the present time to make use of torsion or crushing in dealing with the larger blood vessels. In the largest ones like the femoral or axillary, it is best to apply two catgut ligatures from two to five mm. apart.

Hemophilia. In instances of hemophilia, operations should always be avoided if at all possible. If it is apparent that at some future time an operation will become necessary it may be well to make use of preliminary treatment. In several cases we have found benefit from giving these patients

egg-albumin in considerable quantities, using the whites of three to six eggs raw, night and morning for a number of months. The administration of 200 grams of ten per cent. solution of gelatine internally every day for a period of six months, has been found beneficial in these cases. These substances can be disguised in various ways to secure palatability.

Pre-operative milk diet favors hemostasis. It has also been shown experimentally that the amount of bleeding is much less in patients who have had a liberal milk diet for several weeks previous to operation, consequently where hemorrhage is feared it is well to place the patient on a full diet of milk and egg-albumin, and only enough other food to keep the appetite stimulated.

There is no other remedy which is so effective in stopping hemorrhage even in patients suffering to a marked degree from hemophilia as transfusion of whole blood according to the method described in another chapter.

Other remedies to reduce hemorrhage. Several remedies have been much used prophylactically to reduce hemorrhage. Of these chloride of calcium has received the greatest amount of prominence since its introduction by Mayo Robson, especially in the surgery of the biliary tract. Robson employs this remedy both before and after operation, giving thirty grains in half a pint of water three to six times daily by mouth for two or three days before the operation, and sixty grains in a pint of warm water by rectum thrice daily after the operation for two or three days, or longer. We have used this remedy in many cases but not with as satisfactory results as anticipated.

Ten-grain doses of gallic acid given every two hours in gelatin capsules for from one day to one week, in cases in which it has seemed desirable to reduce the amount of hemorrhage, have seemed to lower the amount of blood lost during operation to a very marked extent. Where it does not seem wise to postpone the operation for more than a few hours, we have given ten-grain doses of gallic acid hourly for a period of from ten to fifteen hours without having observed any harmful effect from the relatively large amount of the drug in a short period of time, while it has seemed that the effect in reducing the hemorrhage has been quite marked even under these conditions.

We have repeatedly made a subcutaneous or intravenous injection of horse serum with the hope of increasing the coagulability of the blood, as suggested by many authors. It has seemed to benefit these patients, but so frequently the hemorrhages stop without any apparent cause that there is a possibility that the improvement has been a coincidence in our cases although we have not thought so. Coagulose, a recent preparation of the essential blood coagulating ferment, appears to have but little merit as a hemostatic.

In a number of cases we have obtained splendid results in reducing the tendency toward hemorrhage by transfusing the patient with blood. The blood thus given seems to furnish elements necessary for clotting which are lacking in the patient. The reduction in coagulation time is not necessarily permanent, but will serve to tide over the time of operation. The method of transfusing will be found described elsewhere.

Determination of coagulation time. When there is reason for suspecting a hemorrhagic tendency (as in cases with icterus, leukemia, etc.), it is well to determine the time of coagulation of the blood previous to operating. This time is estimated by drawing blood from a needle wound into a small bored glass tube (about 1 mm.) up to a standard mark, and then at minute intervals blowing gently through the other end of the tube. As long as the blood is

fluid it will leave the bore and form a drop at the end of the tube. The drop is easily drawn back into the tube. When the blood is clotted, it either remains lodged, or emerges as a plug.

The tube can be standardized by determining the coagulation time of the blood of several normal individuals.

ENVIRONMENT

Temperature of the operating room. The atmosphere in an operating room should be between 68 and 72 degrees F., because such a temperature is about the average for dwellings in this country, and the air heated to this point is comfortable both to the patient and the operator. If lower it is likely to be cooler than the patient is accustomed to breathe; if warmer, it is likely to be oppressive to the operator and he can scarcely be expected to do his best work when he is practically smothered by hot air. The patient's body should be protected, except at the field of operation, and this need not be so large as to cause chill. It is well to place hot water-bags about a patient on the operating table if the operation is expected to be of long duration.

Warm operating tables. Operating tables have been constructed with double tops which can be filled with water heated to 120 degrees F., and which will remain warm throughout the operation, or which can be kept at a given temperature by the use of an electric heater.

Another useful contrivance has been invented in the form of a flat rubber mattress which fits upon the top of the operating table and which is filled, before the patient is placed upon it, with water heated to 120 degrees F. This is exceedingly simple and very satisfactory.

Another plan consists in a row of incandescent electric lights underneath the table which, when lighted, will supply the proper amount of heat.

With an operation of less than one hour's duration none of these expedients is necessary, and if employed in cases of longer duration, the simpler the method the more useful it is in practice.

Influences affecting shock. It was thought at one time that shock was caused in abdominal operations by the exposure of the intestines to a temperature so much below that of the body, but this theory is no longer tenable, because no abdominal operator exposes the intestines to the atmosphere. The shock referred to above was undoubtedly due to the extensive manipulations of intra-abdominal organs practised at that time.

If all of the safeguarding conditions are properly considered as a matter of habit in connection with surgical work, and all means of correction followed, it will be found that the post-operative disturbances, especially those due to shock, will be very greatly decreased.

There is a decided difference in the amount of shock from which patients suffer after similar operations performed by different surgeons, and we believe that this difference is due largely to the fact that some surgeons habitually apply all of the principles involved in the above considerations which bear upon the limitation of shock, while others as habitually disregard them.

It is also well to bear in mind the fact that there is much less likelihood of exposure of intestines to the air when they are empty, and consequently in a thoroughly collapsed condition, at the time of the operation than if they are distended with gas to a varying degree. In all cases in which it is possible to make preliminary preparation this condition may be attained by giving

the patient two ounces of castor oil the day before the operation, and then giving him nothing to eat except broth for twenty-four hours previous to the operation.

Mental impressions and premonitions. We have adopted the rule never to operate in case a patient is afraid or has a premonition. In these cases except in the presence of some very acute condition which makes the operation an absolute necessity, like strangulated hernia, intestinal obstruction due to a mechanical cause, etc., the patient always has a very much better chance of recovery if one postpones the operation until this feeling of fear or premonition has passed away and the patient asks to be operated upon.

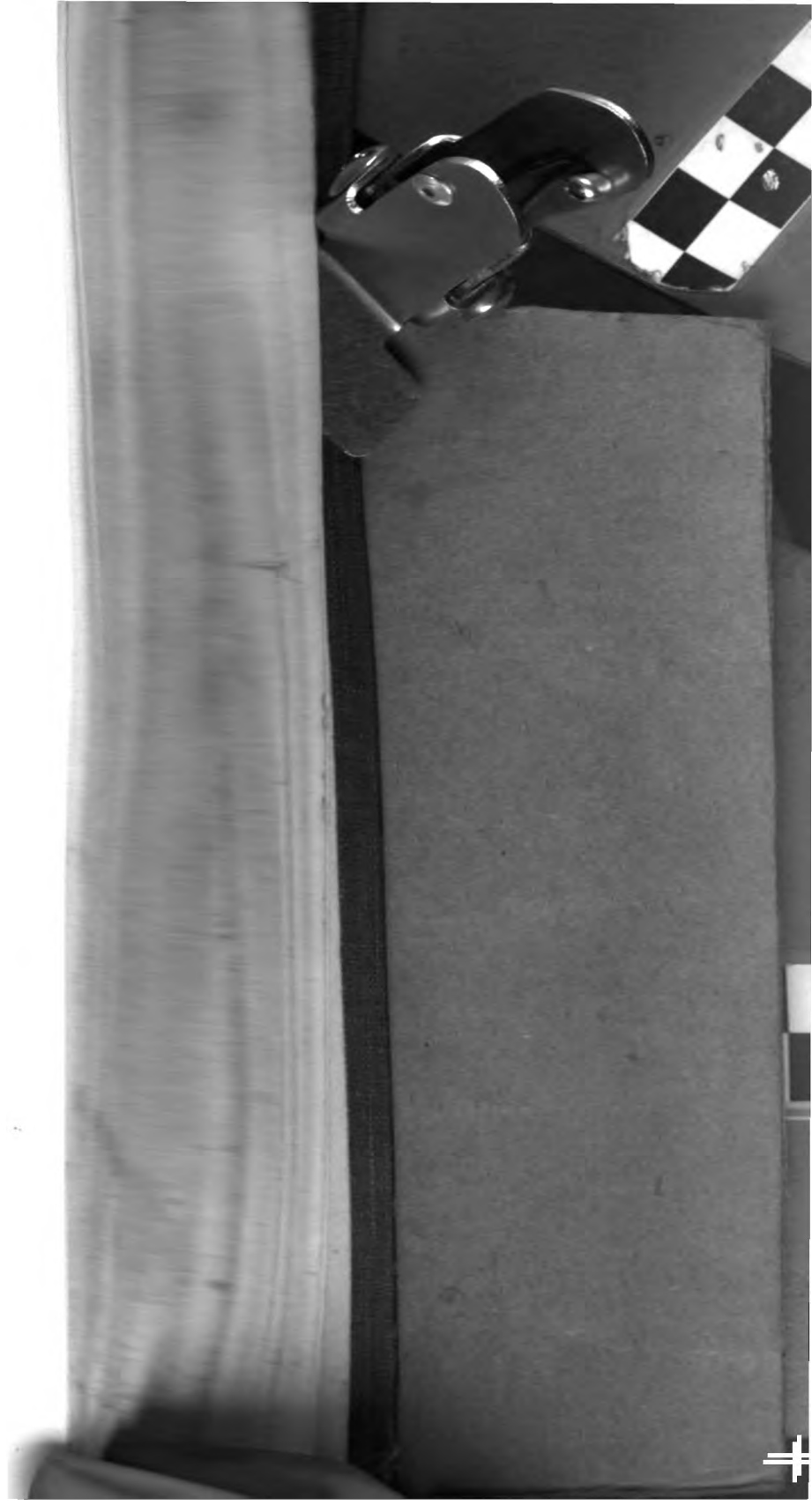
We have encountered several cases in which our disregard of this condition has resulted seriously to the patient.

In at least two cases in our experience the nervous shock due to the anticipation of an operation was so severe as to kill the patient before he was transferred to the operating room. One of these cases occurred in a man about sixty years of age upon whom we had planned to perform a prostatectomy. The patient was seen at 8 A. M. He was normal in every way. The urine was normal, the blood pressure nearly so, his heart action was good and he seemed in an excellent condition to undergo the operation, which had been set for 10 A. M. The patient was, however, very much frightened over the impending procedure. About 9:30 his special nurse came to the operating room and said that her patient had been getting more and more nervous so that she was getting quite alarmed about him and begged that we should call at once to encourage him. Upon reaching his room, immediately, he was found dead.

A second case in a patient about 35 years of age, normal in every way except that he was suffering badly from hemorrhoids, followed a very similar course. The morning upon which he was to be operated the nurse said that the patient's heart seemed to act abnormally. We went to the ward at once and found the patient terribly frightened and almost pulseless. The nurse reported that she was unable to count his pulse when she had first reported. His breakfast was ordered because we had decided not to operate upon him. He became quiet at once and within an hour his pulse was normal. Two days later we decided to perform the operation, because he was again perfectly normal in every way. As the time approached he again became very nervous and asked the nurse to bring him a glass of water. As she proceeded to carry out his wish she heard a sound and upon turning to determine the cause of this sound she found that he had fallen over from the sitting posture which he had occupied and that he was dead.

There can be no doubt but that many cases that die during operation, or shortly after, belong to the group of which these two cases are characteristic examples. Of course, it would be an easy matter to attribute fatalities which should rightly be credited to bad surgery to this cause, precisely as the anesthetic is blamed for a lot of bad surgery. On the other hand, there can be no doubt but that deaths do occur as a result of fear of surgical operations.

Cathartics to be avoided in peritonitis. Of course, the giving of castor oil, as well as all other forms of cathartics, and also of any form of food, is absolutely contraindicated in all those suffering from any form of peritonitis. The same is true even with greater force in all cases of intestinal obstruction, but in these two classes the gaseous distension can be most effectually relieved by carefully executed gastric lavage, which may be repeated several times if necessary, and by placing absolutely nothing in the stomach, not even water, giving nourishment exclusively by rectum, preferably by



the use of an ounce of one of the various concentrated predigested liquid foods diluted with three ounces of normal salt solution, through a small catheter introduced into the rectum not more than three inches. It is best to pour the fluid into a funnel or a glass syringe attached to the catheter and permit it to enter the intestines by gravitation. To this treatment should be added the proctoclysis of normal salt solution introduced by Murphy, to be described later.

In every case belonging to these two classes no form of nourishment and no form of cathartics should ever be given by mouth.

PREPARATION OF THE PATIENT FOR OPERATION

Various steps. The first step in the preparation of the patient after his entrance into the hospital, or after an operation has been decided upon, is to once more make a thorough examination either in person, or, better, still, by an equally competent associate. This examination should be made independently by the associate and then the results should be compared. It should be made in a systematic way and, in hospital practice, at a stated period, so that enough time will be allotted to make it thorough. It is true that this plan increases the amount of labor materially and that it is only very seldom that any new facts are determined by the second examination, but it is just in the few cases that it proves to be of the greatest importance. It is extremely easy to form careless routine habits unless one constantly follows a definite, scientific plan. It does not matter especially what plan is followed so long as it is comprehensive.

Below is given an outline for the routine history and physical examination of a patient. The outline may be too complete for some cases, but it is well to follow it as often as possible as surprising points are often brought out. Indeed the outline is not as complete as necessary in many cases—but is more an indication of method.

It is often necessary to make certain additional examinations—laboratory and clinical—and an outline of these procedures is appended. The urine and blood examinations are routine with us; the others are done when indicated.

CLINICAL HISTORY

1. Statement of complaint.
2. *Family history.* Present condition of health of father, mother, brothers and sisters, if living; causes of death, if dead.
   History of tuberculosis, cancer, diabetes, gout, hemophilia and nervous diseases.
3. *Marital history.* Years married. Condition of health of husband and children, if living. Causes of death, if dead. Miscarriages—their time relation to last successful pregnancy.
4. *Habits.* Coffee—Tea—Alcohol—Tobacco—Drugs—Habits of eating—Appetite—Bowels—Sleep.
5. *Occupation.* Question closely, if indicated, for some feature of occupation—sanitary condition, hours, nature of patient's particular job; materials used, etc.—that might throw light upon the complaint.
6. *Injuries.*
7. *Operations.*

8. *Insurance.*
9. *Past history.*
   (a) *Infectious fevers* (Exanthemata, diphtheria, typhoid, pneumonia, malaria, rheumatism, chorea, etc.).
   (b) *Head.* Injuries—headaches.
   (c) *Eyes.* Glasses—failing vision.
   (d) *Ears.* Tinnitus—abscess—earaches—discharge.
   (e) *Nose.* Colds—catarrh.
   (f) *Teeth.* Abscesses, ulcerations.
   (g) *Throat.* Sore throats, tonsilitis—hoarseness.
   (h) *Neck.* Swelling—stiffness.
   (i) *Cardio respiratory system.* Cough, sputum, pleurisy, chest pain, night sweats, weakness, dyspnea, palpitation, precordial pain, edema,
   (j) *Gastro-intestinal system.* Abdominal pains—vomiting—nausea—gastric distress — belching — constipation — diarrhea — hemorrhoids—jaundice—clay and tarry stools.
   (k) *Genito-urinary.* Nocturia— frequency — dysuria — pyuria — smoky urine—hematuria. Venereal disease by direct questioning or symptomatically.
   (l) *Catamenia.* Time of beginning—regularity—period—duration—character. *Date of last period.*
   (m) *Neuro-muscular system.* Ataxia — dizziness — lightning, joint, muscle and girdle pains, etc.
   (n) *Weight.*
10. *Present illness.*

PHYSICAL EXAMINATION

General observation. Development—Nutrition—Evidence of pain or distress—Mental state.
Skull. Symmetry—Exostoses—Tender areas.
Scalp.
Face. Expression—Symmetry, etc.
Skin. Texture—Nutrition—Color (Anemia, Hyperemia, Cyanosis, Icterus, Pigmentary) Eruptions—Moisture—Temperature—Vaso-motor changes—Edema—Emphysema—Collateral circulation—Trophic changes—Anesthesia—Hyperesthesia—Paresthesia.
Eyes. Pupils — Scleræ — Photophobia — Lachrymation—Diplopia, Nystagmus, Ptosis, Strabismus, Exophthalmos, Lid-lag, etc. Conjunctivæ. Gross disturbances of vision.
Ears. Discharge—Stigmata—Tophi—Hearing.
Nose. Deformities—Obstruction or discharge.
Mouth. Breath—Ulceration—Exudate—Pigmentation.
Lips. Color—Herpes—Ulcerations—Fissures.
Teeth.
Gums. Color—Pyorrhea—Bleeding—Lead line.
Tongue. Color—Coating—Mucous patches—Tremor—Protrudes in mid line?
Tonsils. Size—Exudate—Crypts—Injection.
Pharynx. Color—Catarrh.
Palate. Mid line? Gag reflex.
Larynx. Voice.

Neck. Thyroid—Lymphatic glands—Pulsations—Stiffness—Tracheal tug.
Thorax. Symmetry — Size — Shape — Expansion — Respiration — Pulsations — Breasts.
Heart. Location and character of apex impulse—Rhythm—Shocks and thrills—Borders of cardiac dullness—Aortic dullness—Character of sounds and murmurs at the various valve regions—Friction rubs.
Vessels. Sclerosis—Rate—Quality—Compare simultaneously the two radial pulses as to time, quality, etc.
Blood pressure.
Lungs. Tactile fremitus—Percussion—Breath sounds—Vocal fremitus—Rales—Friction rubs, etc.
Abdomen. Level—Shape—Symmetry—Respiratory movements—Abnormal pulsations—Tumor masses—Tenderness—Spasm—Evidence of fluid—Herniæ.
Liver. Area of dullness—Palpable?—Character of surface.
Gall bladder. Palpable? Tenderness.
Spleen.
Kidneys. Palpable? Tenderness in costo-vertebral angles.
Lymphatic glands. (Neck, axillæ, groin, epitrochlear.)
Bones. Spine. (Shape—Deformity—Rigidity—Tenderness.) Long bones—Exostoses—Irregularities.
Joints. Deformities—Pain—Tenderness—Swelling—Motion.
Extremities.
(a) *Arms.* Wasting—Involuntary movements—Tremors—Clubbing of fingers—Nails, Biceps, Triceps and Periosteoradial reflexes.
(b) *Legs.* Varicosities — Scars — Ulcers — Edema—Gait — Knee jerks — Achiles and plantar reflexes, Babinsky, Gordon, Oppenheim and Kernig tests—Clonus—Rhomberg.
Rectal examination. Fissures—Fistulæ—Hemorrhoids—Strictures. (Prostate gland and seminal vesicles—in the male.)
Male genitalia.
Penis. Sores—Discharge, etc.
Testicles. Evidence of tuberculosis. Varicocele—Tumors.
(See Rectal.)
Vaginal examination.
External genitalia.
Condition of perineum.
Vagina—Discharge.
Condition of cervix—Ulcerations, etc.
Size and position of uterus.
Tumors.
Adnexa—Tumors and tenderness and induration.
Minute local examination of diseased parts.
Laboratory examinations.
Urine analysis—routine for all cases.
Examination of stool.
Gastric contents analysis.
Blood examination (red and white cell count—Hemoglobin—Differential count).
Microscopic examination of vaginal and urethral smears, etc.
Sputum examination, if indicated.
Serum reactions (Widal, Wasserman, etc.).
Examination of spinal fluid.

Bacterial cultures from discharges, if indicated.
Blood cultures, if indicated.
Examination of body fluids, if indicated.
Animal inoculations, if indicated.

Special examinations.

Ophthalmoscopic.
Otoscopic.
Laryngoscopic.
Proctoscopic.
Cystoscopic.
Bronchoscopic.
Esophagoscopic.
Neurological examination—including objective and subjective findings concerning each cranial nerve; disposition; emotion; memory; intellect, etc.; motor system (atrophy, weakness, paralysis, reflexes, etc.); sensation (disturbance of sensation of touch, pain and temperature, anesthesia, paresthesia, hyperesthesia, etc.); vaso-motor system, sphincter disorders, sexual disorders, etc.
X-ray examinations.
Gastro-intestinal with bismuth.
Bones—Chest—Skull, etc.
Tissue examinations.

Value of conjoint diagnosis. Another element of considerable value might be mentioned. If the surgeon knows that all of his cases are to be examined thoroughly by an equally competent colleague or assistant, he is not so prone to become careless in his personal examinations as his work accumulates. This is one of the most common causes of reduction in the success of surgeons who have been eminently successful. Aside from the natural tendency with advancing years to give less and less attention to details in the general planning and management of the work, nothing is so certain to displace the older members of the surgical profession as a tendency to make a less thorough diagnosis as the years increase.

On the other hand nothing can be of greater importance in the development of the younger surgeon than an opportunity to make a large number of careful, systematic, clinical examinations in cases which have been, or are to be, carefully examined by a senior surgeon of vast experience and to be compelled to make an independent diagnosis in these cases, especially is this true if a detailed, written diagnosis is made by each examiner.

SPECIAL METHODS OF EXAMINATION

During the past few years a number of methods have been developed for the examination of patients by the use of various vaccines and by variously prepared blood sera.

In the diagnosis of tuberculosis, syphilis, carcinoma and sarcoma much valuable work has been done. Many of these methods are undergoing such rapid changes that it will not be wise to describe them here in detail, because better methods than any now in use will undoubtedly be advanced in the current literature before many months. It should be stated, however, that all of these procedures are worthy of much attention and should be considered, at least when they confirm a diagnosis made by means of older methods of examination.

TUBERCULIN TESTS

In cases of suspected tuberculosis, in which no material containing tubercle bacilli can be obtained, demonstrations of the lesion by means of tuberculin tests is often possible. It should be emphasized, however, that all types of tuberculin tests are only to be interpreted in the light of clinical history and local or general evidences of disease.

In ordinary practice the forms of tuberculin test commonly used are the "subcutaneous"—the "skin test" (Von Pirquet) or the "ophthalmic test" (Wolff-Eisner and Calmette). Each type of test has its useful field, but most instructive clinical information is given by tuberculin subcutaneously given.

The subcutaneous tuberculin test. It is, of course, necessary to here mention that where sputum is thick with bacilli, where the physical signs at the suspected focus are evident, or where the clinical course of the disease is characteristic, the injections are not indicated. Every effort should be made to find bacilli in the sputum by repeated examinations of fresh specimens; every opportunity should be used to discover local alterations; every detail in the patient's history and present condition should be scrutinized. For, if this is not done, the interpretation of the picture after the injections may be faulty and misleading, and, perhaps, the source of much inconvenience and anxiety to the patient. If the above conditions have been satisfied and one still finds the positive diagnosis obscure, although he may strongly suspect the nature of the disease, it is good practice to advise the diagnostic injections.

In order to insure dependable results, it is quite essential that the following facts be observed:

The patient should be under no antipyretic medication at the time that tuberculin tests are being carried out. It is a good rule to stop all medication a day or two before the time for the proposed injections.

The patient's temperature should be shown to be within the normal range —or with very slight variations—by two-hourly recorded observations for two or three days previous to the injections. The pulse and respiratory rate should be likewise determined.

The patient's physical signs at the suspected focus should be accurately observed. This is necessary in order that the condition after the injections may be compared with that existing before.

The general condition of the patient should be noted; for example, the presence or absence of headache, of backache, or neuralgia, or pain in the joints, or pain in such special regions as the kidney or the eye.

The existing condition in any surface lesion should be observed.

Any coexisting ailment, as tonsilitis, gastric disturbance, et cetera, contraindicates the injections.

It is advisable to have the patient rest quietly at least part of the day preceding the evening on which the tuberculin is to be injected. Sometimes the extra duties which have to be performed in view of a few days' absence from school or office bring about general or subjective changes which obscure the reaction.

The injections. The injections are very conveniently made with an all-glass hypodermic syringe (as the Luer). This form of syringe is compact and easily kept clean. The site of the injections is usually the soft tissue in the interscapular region, the upper thorax or the flanks. The skin should be prepared as for other forms of hypodermic medication. After the tuberculin solution has been injected, the needle puncture should be sealed with cotton and collodion. This procedure lessens the danger of local infection from clothing, and the like.

It is our custom to give the injections in the dosage suggested by Koch for the "old tuberculin." The initial injection consists of one milligram of "old tuberculin" and is best given at bedtime. The patient is kept quiet, preferably in bed, all of the next day. This detail cannot be too strongly insisted upon, inasmuch as sometimes even what may appear to be slight disturbances—as, for example, examination by many people, a walk to the dining-room, an exciting game of cards—will render observations of doubtful value.

The reaction. This depends upon several factors, chief of which are the physical condition of the patient, the dose of tuberculin administered, the environment of the patient, and to some degree the stage of the tuberculous process. The interpretation of the reaction is guided by the observation of several features of its manifestation. These are: (a) the increase in temperature in tuberculous individuals following injections of tuberculin; (b) the constitutional evidences of acute intoxication, and (c) the local alterations at the site of the suspected lesion. Each phase will be considered somewhat in detail.

(a) The rise in temperature. In typical cases, this begins about eight hours after the injections, although it may be delayed for some time longer. The ascent is rather gradual. In most cases, where the tuberculous process is not far advanced, the temperature rises one and one-half to three degrees above the normal. It may remain for several hours at this point, and then falls quite rapidly. The rise in temperature is frequently preceded by a slight fall. In order to appreciate the variations in the temperature curve, it is advisable, whenever possible, to have hourly observations as soon as the temperature curve shows a tendency to go upward. No rise in temperature of less than one and one-half degrees should be considered anything more than suspicious. Nor has it appeared to us that evidence of increased temperature of itself should be considered positive proof of tuberculous infection. It should arouse such suspicion as will lead to close investigation of the suspected focus.

(b) The constitutional manifestations of reaction. In typical cases, coincident with the rise in temperature, the patient may complain of feeling tired, of headache, of pains in the muscles, of pains in the joints. There is often a sensation of chilliness, rarely an actual chill. Anorexia is common, particularly where the febrile reaction is prompt and marked. There is occasionally nausea; this is not always the case, however, as some patients exhibit either of these manifestations of reaction without the other. The constitutional discomfort usually persists for a longer time than does the temperature rise.

(c) The local evidences of reaction. Commonly, especially in cases of incipient pulmonary tuberculosis, this feature is overlooked, and should there be no rise in temperature or constitutional symptoms, a negative report is returned. The careful examination of the local alterations after injections of tuberculin should never be neglected. In some cases it is the only striking feature of the reaction, and may of itself be the strongest in making a positive diagnosis. The local changes in the lungs may make themselves manifest by harsher breath-sounds, greater increase in transmission of the whispered voice, the presence of râles where none had before been discovered, or an increase in their number or an alteration in their character. In affections of the pleura, there may be development of a pleural friction rub, or in some cases the disappearance, or the lessening, of one that before existed. In joint disturbances there is often pain or soreness, swelling, or impaired function. Skin lesions exhibit greater vascularity, with redness and swelling. In affections of

the larynx or the various parts of the eye, one frequently observes added evidences of engorgement. In renal affections local tenderness or pain, with the presence of albuminuria, may be noted.

Duration of the reaction. In the majority of positive cases, the evidences of reaction have disappeared within thirty-six hours. Sometimes the reaction begins late and may thus appear to be prolonged. This may be noted in old, fibroid cases. It is essential that the patient be kept at rest and thoroughly examined from all standpoints just so long as he presents any deviation from his previously-noted condition. In cases where the reaction appears to be especially late in its onset, or prolonged in duration, it has always seemed advisable to us to look for other causes to which the change might be ascribed. We have seen instances where evidences of local infection at the site of the injections, tonsilitis or gonorrhea, confused the picture.

Repeated injections. When the injection of one milligram of tuberculin produces no reaction as described, the patient cannot be said to be free from infection. He should be kept quiet for from three days to one week and, under conditions before mentioned, an injection of five milligrams of tuberculin may be given. For at least two days following the second injection the patient's condition should be carefully observed. If with this second injection there is no effect produced, then after another resting period of from three days to one week, an injection of ten milligrams may be given, and the patient observed as before. To many clinicians a negative result with the injection of ten milligrams of tuberculin is deemed all that is necessary to exclude tuberculous infection. There are other observers, however (Koch, Marx), who recommend that the final dose of ten milligrams should be repeated before it can be said positively that a suspicious case is free from infection. If there is any tendency shown to reaction of a given dose, then it is deemed good practice to repeat that dose before larger doses are administered. In all events, the injections should not be given at too frequent intervals, else an immunity may be established and no reaction result.

Anaphylactic reaction should be borne in mind.

Preparations of tuberculin used for therapeutic effect. The preparation of choice is the "new tuberculin" of Koch. The "bacilli emulsion," the "watery extract" of von Ruck, and the serum of Maragliano are frequently used. The injections are preferably given at night. It is best to keep the patient quiet the day following. Examinations should be made as when tuberculin is used for diagnostic purposes. The temperature, the constitutional symptoms and the local changes should be observed.

Dosage. In giving the injections care should be taken that only freshly prepared solutions be used. If they have been kept longer than twenty-four hours, it is advisable to discard them. If they are at all cloudy they should not be used. Although one cannot say that there is any set rule regarding the amount of the beginning injection, yet it appears to us that working with the "new tuberculin" of Koch it does not seem that so small a dose as one-thousandth milligram should be used. We fully realize that even smaller doses than this have been recommended, yet unless one is giving such with some special scientific problem in view, these small doses are frequently a waste of time, and are certainly an annoyance to the patients. Doses of one five-hundredth milligram are safe, in the majority of instances. They usually produce recognizable effects, and they are not so large as to be dangerous. If larger doses are used at the outset, a true tuberculin reaction may result, and if these doses are frequently given, the "cumulative" effect (prolongation of

the "negative phase") may be disastrous. The effect on the opsonic index or the evidences of local or general reaction are the only true guides to the amount of tuberculin to be injected. In view of the difficulties in respect to the former, the close scrutiny of the local focus furnishes most valuable information regarding the size of dose after the initial injection.

If no reaction other than local follows the initial injections, then the size of the dose can be gradually increased, as, for example, to one two-hundredth milligram, to one one-hundredth, one-fiftieth, one-twenty-fifth, and so on. Cumulative action may be avoided by giving the injections at intervals of from five to ten days, as indicated. When possible, opsonic estimations should control the injection-time. If this is not possible, then if at any time there is even the slightest evidence of rise in temperature, constitutional symptoms or marked aggravation of the process—especially if this is persistent—in the affected part, the injections should be discontinued for a time. When they are again begun, the dose should be reduced to one-half of the one which caused the acute exacerbation. If these details are attended to then, as shown by Jeans and Sellards, in many cases the satisfactory progress of the case is possible without the opsonic estimations.

Much harm has been done patients by the practice of pushing the use of vaccines to high dosage. It is by far better to continue a dosage equal to one-half the lowest dose causing a reaction.

The "skin test" (Von Pirquet.)—The cutaneous reaction. Apply a drop of pure, "old" tuberculin to the skin and make through it with the point of a scalpel a few very superficial incisions. As controls, incisions are made in the bare skin and also through a drop of fifty per cent. glycerin. It is aimed to make the incisions so superficial that there will be no bleeding, but frequently a few small drops of blood appear along the line of incision. This seems in no way to interfere with the delicacy of the test. In the beginning we allowed the tuberculin to remain on the arm two or three minutes after the incisions were made, then covered it with a small piece of gauze held in place by straps of adhesive plaster. In this way the tuberculin is kept a longer time in contact with the skin. More recently we have allowed the drops to remain for at least five minutes after incision before covering them with gauze. This difference in the length of exposure has made absolutely no change in our results and is, we think, of quite secondary importance.

The result of these tests we have classified under five headings:

1. Negative Reactions.—No redness or infiltration about the incisions.
2. Slight Reactions.—Definite redness and some infiltration about the incisions.
3. +Reaction.—Rather wide area of redness which is definitely raised.
4. ++Reaction.—Wider area of redness and more marked elevation than +.
5. +++Reaction.—Unusual redness and a wide area of infiltration.

The ophthalmic test (Wolff-Eisner and Calmette) or conjunctival reaction. Recently M. A. Calmette has described a new diagnostic reaction with tuberculin. When a drop of one per cent. solution of tuberculin is instilled into the conjunctival sac of a patient suffering with tuberculosis, there appears a marked congestion of the conjunctiva, accompanied by edema more or less intense, and a sero-fibrinous exudate. This reaction begins about three hours after the instillation, and reaches its maximum in about six hours. The reaction is not accompanied by temperature changes, and has little or no inconvenience except the localized symptoms in the eye.

Interpretation. Negative.—No discernible difference in the two conjunctivæ.

Slight or doubtful.—Conjunctiva of the eye receiving the injection a little redder than the other eye, but the difference not marked enough to permit the reaction to be called definitely positive. In most instances the redness and injection are limited to the caruncle.

+.—Definite palpebral redness.

++.—More marked palpebral redness with secretion.

+++.—Palpebral and bulbar redness with subjective symptoms and well-marked secretion.

In making the readings the lower lids are well pulled down and the patient directed to move the eyes in different planes. It will be appreciated that a slight or doubtful reaction to a conjunctival test is quite different from a slight reaction to the cutaneous test.

TECHNIQUE FOR MICROSCOPICAL EXAMINATION OF BLOOD

Obtaining the blood from the patient. For microscopical examination the blood is preferably obtained from the lobe of the ear, which is cleansed thoroughly with alcohol on a sponge, it is then wiped dry with sterile cotton, rubbing rather vigorously so as to produce a slight hyperemia. The style of needle to be used is of little importance. It should be kept immersed in alcohol when not in use. The point of the needle is inserted into the inferior surface of the most dependent part of the lobe, far enough to cause the blood drop to form without using pressure. The first drop is wiped away. The next drop is employed to determine the hemoglobin. For this purpose the Tallquist hemoglobin scale is used. A bit of paper from the book (which accompanies scale) is held in apposition with the freshly-formed droplet. This is never allowed to dry. The color is matched according to the scale at once. This is accurate enough for all practical purposes.

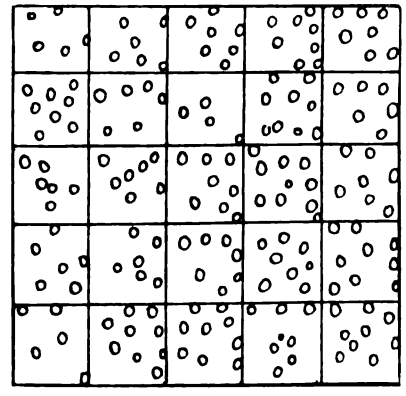
The Thoma-Zeiss apparatus. The next step is to fill the red blood counter pipette. The Thoma-Zeiss apparatus is used. A fresh drop is allowed to form; the tip of the pipette is placed against the drop (never touching the ear) the blood is sucked up to the mark 0.5 (precision is essential), the tip is wiped off and the pipette is plunged into normal NaCl or Havem's solution; the pipette is filled with this up to the mark 101 and then twirled about so that the salt solution and blood become intimately mixed. By this procedure hemolysis and crenation are prevented and the blood is diluted two hundred times. The next step is to fill the leucocyte counter. A fresh drop is allowed to form—the leucocyte pipette is filled with blood to the mark 0.5 and the tip is cleansed and the pipette is then filled to the mark 1.1 with three per cent. acetic acid. The acetic acid dissolves the hemoglobin out of the red cells. A slight inaccuracy in filling this pipette will cause a great error in the final result. The dilution is 1-20 in the pipette. For making a differential count, a drop of blood is allowed to fall on the end of a glass slide or thin films of blood are made on cover-slips. The glassware must be absolutely clean and free from fat, etc. The drop should be a small one.

A bit of cotton is placed against the patient's ear to catch a drop or two which may ooze out. The blood is now ready for microscopic examination The Thoma-Zeiss chamber is used.

Counting erythrocytes. The pipette is then twirled again so as to make certain that there is a uniform distribution of the corpuscles and a few drops are blown out (the part which has not been in the bulb contains mostly salt

solution and few corpuscles). A drop is then placed on the platform of the counter and is covered with one of the specially ground glasses which go with the instrument. This step requires care. There must be no air bubbles; the entire platform should be covered and none of the liquids should run into the moat. If these requirements are not fulfilled, remove the cover-glass, clean the chamber and use a new drop. When the satisfactory drop is obtained, allow the corpuscles to settle and examine with the low power of the microscope. Be sure that the corpuscles are evenly distributed.

The following is a quick and fairly accurate method of determining the number of erythrocytes. Altogether eighty (5x16) small squares are counted. To the total number of cells counted four ciphers are added and the result gives the number of cells in a cubic mm. In counting the little squares, all the cells



5	6	7	8	7
8	6	4	9	6
6	7	8	10	7
6	6	7	8	9
5	9	9	8	9

touching the right hand and upper boundaries of the square are included in count.

Counting the leucocytes. The drop is prepared according to the same procedure, the same precautions being used. The cells in the entire field of four hundred squares are counted. The drop is wiped off and the slide cleaned and this performance repeated. Three drops altogether are counted. The difference between the counts of the various drops should not exceed eight at the most. If there is a greater discrepancy, faulty technique is to blame. Determine the leucocyte count thus:

Drop A—42.
Drop B—42.
Drop C—46.

130

This sum divided by three gives an average of 43.33 per sq. m.m. This multiplied by two hundred equals 8,666, the number of leucocytes in a cu. m.m.

Color-index. By this term is meant the ratio existing between the hemoglobin per cent. and that of the red cells, on the basis of 5,000,000 red cells equalling one hundred per cent. of hemoglobin. By this rule 1,000,000 red cells should correspond to twenty per cent. of hemoglobin.

In some diseases, such as pernicious anemia, the hemoglobin per cent. is higher than the red cell per cent. because of the increased size of cells. To illustrate; in a given case the hemoglobin is thirty per cent.; the red count 1,000,000, or twenty per cent.; the color-index is 3/2; or in a given case, e.g.,

the hemoglobin is eighty per cent. the red cells 4,200,000 (eighty-four per cent.) thus:

$$\frac{4{,}200{,}000}{5{,}000{,}000} \times 100 = 84. \quad \text{The color index} = \frac{80}{84} = .95$$

Differential count. Wright's stain is commonly used. If filtered daily it keeps indefinitely and is perhaps the best stain for routine work.

Staining of blood-films. I. 1. Make films of the blood, spread thinly, and allow them to dry in the air.

2. Cover the preparation with the alcoholic solution of the dye for one minute.

3. Add water to the alcoholic solution of the dye on the preparation, drop by drop, until the mixture becomes semi-translucent and a yellowish, metallic scum forms on the surface. Allow this mixture to remain on the preparation for two or three minutes.

4. Wash in water (preferably distilled) until the film has a yellowish or pinkish tint in its thinner or better spread portions.

5. Dry between filter-paper and mount in balsam.

Dried blood-films may be kept for some weeks without impairment of their staining properties; but if kept too long will not give good results.

MICROSCOPICAL APPEARANCES IN BLOOD-FILMS STAINED BY THE METHOD OF WRIGHT

Red cells are orange or pink in color; polychromatophilia and punctate basophilia (the granular degeneration of Grawitz) are well brought out. The nucleated red cells have deep-blue nuclei, and the cytoplasm is usually of a bluish tint.

Lymphocytes have dark purplish-blue nuclei, and robin's-egg-blue cytoplasm in which a few dark-blue or purplish granules are sometimes present.

Polynuclear neutrophilic leukocytes have dark-blue or dark-lilac colored nuclei, and the granules are usually of a reddish-lilac color.

Eosinophilic leukocytes have blue or dark-lilac colored nuclei. The granules have the color of eosin, while the cytoplasm in which they are imbedded has a blue color.

Large mononuclear leukocytes appear in at least two forms. Each form has a blue or dark-lilac colored nucleus. The cytoplasm of one form is pale-blue, and of the other form is blue with dark-lilac or deep-purple colored granules, which are usually not so numerous as are the granules in the polynuclear leukocytes.

Mast cells appear as cells of about the size of polynuclear leukocytes with purplish or dark-blue stained, irregular-shaped nuclei, and cytoplasm, sometimes bluish, in which numerous coarse spherical granules of variable size are imbedded. These granules are of dark-blue or of a dark-purple color, and may appear almost black.

Myelocytes have dark-blue or dark-lilac colored nuclei, and blue cytoplasm in which numerous dark-lilac or reddish-lilac colored granules are imbedded.

The blood-plates are deeply stained, and are a prominent feature of nearly every blood preparation. They appear as blue or purplish, rounded or oval bodies, usually of a diameter of a third to a half of that of a red blood-corpuscle. Sometimes they appear in groups or masses, and at first sight may be regarded as precipitates. In many instances they have the appearance of

being within a red corpuscle and surrounded by an unstained zone of its cytoplasm.

Malarial parasites. The body of a malarial parasite stains blue, while the color of the chromatin varies from a lilac-color through varying shades of red to almost black. In the young forms of the tertian and aestivo-autumnal parasite the chromatin appears as a spherical very dark-red body, while in the older forms of the tertian parasite it has a more lilac or purplish-red color, and may appear in the form of a reticulum. In the intermediate forms the color of the chromatin may present variations between these extremes. The inexperienced observer may mistake the blood-plates apparently situated within the red blood cells for malarial parasites. This will not occur if he bear in mind that the young parasite of all the three kinds should present by this method a dark-red spherical nucleus, and a cytoplasm which is usually in the form of a definite ring. This method of staining will bring out dark-red staining granules in the red corpuscles harboring malarial parasites provided the stain after the water has been added to it is allowed to remain on the preparation for at least five minutes, and not to decolorize for so long a time as with the ordinary stain.

Staining method. II. A very satisfactory method is to use Jenner's stain (which may be obtained at any reputable supply house) and methylene-blue. The blood film is allowed to dry in the air. Jenner's stain is dropped on the slide and allowed to act for two minutes. This is then washed off and Loeffler's blue is allowed to act for two minutes. (If Jenner's stain is fresh and of full strength this step is superfluous.) This is then washed off and the smear is allowed to dry in the air. It is now ready for examination. A drop of cedar oil is placed on the slide and the smear is examined with the oil immersion lens.

Staining method. III.—The Ehrlich tricolor mixture. The Ehrlich tricolor mixture has for years been the most popular stain with many workers. The objections to it are (1) that it is difficult to prepare a good stain, and (2) that the films must be fixed by heat. (The first objection may be overcome by sending to Walter Dodd, apothecary to the Massachusetts General Hospital, who furnishes an absolutely reliable stain. Arneill.)

A drop of the stain is spread over the film, allowed to remain five minutes or more, and washed off with water. (It is impossible to overstain.) The specimen should look orange-yellow; if it is brown or red, it is underheated—not overstained. If overheated, everything is blurred and dim under the microscope. Hewes improves the definition of the nuclei by pouring upon the film for a second or two a saturated aqueous solution of methylene-blue, after the triple stain has been washed off with water. This also brings out the malarial parasite.

Differential count. For this purpose the carefully stained specimen is used. The oil immersion lens is used and the slide is moved about by means of a mechanical stage. For ordinary purposes a count of a hundred white cells suffices. If the relative percentage of the various kinds of white cells differ from the normal for the sake of accuracy it is well to count between three hundred and five hundred. As the cells are counted they are recorded in groups.

Normal differential counts. Origin of the different varieties of physiologic leukocytes.

I. The myelogenous group. (From the bone-marrow.)
   (a) Poly(morpho) nuclear.
   (b) Eosinophiles.

(c) Mast-cells.
(d) Large mononuclear cells.

II. The lymphogenous group. (From adenoid tissue.)

Lymphocytes of all sizes.

		Normal per cent. of each variety.
(a)	Small lymphocytes	20-30 per cent.
	Large lymphocytes	4-8 per cent.
(b)	Polymorphonuclear neutrophiles	62-70 per cent.
(c)	Eosinophiles	½-4 per cent.
(d)	"Mast-cells"	1/40-½ per cent.

In infancy the percentage of lymphocytes is much larger (40 to 60), and the polymorphonuclear only 18 to 40 per cent.

Poorly-nourished, debilitated people show an excess of lymphocytes and a diminution of the polynuclear cells. The opposite condition prevails in vigorous health.

Pathologic leukocytes. 1. Myelocyte. This is a mononuclear neutrophile, and has many points of resemblance to the polynuclear neutrophile; it is the same cell in an early stage of growth.

This cell makes up the larger portion of the leukocytes of the marrow, and differs from any variety found in normal blood.

It is found in the blood in various diseased conditions, and resembles very closely the large lymphocytes, differing only in possessing neutrophile granules. It differs from the polynuclear neutrophile in the shape of its nucleus, but the granules in both are alike. The nucleus is usually spherical or egg-shaped, and is in close contact with the cell-wall for a comparatively large portion of its extent. (Arneill.)

Eosinophilic myelocytes. Myelocytes having eosinophile instead of neutrophile granules occasionally occur.

The eosinophile granules do not all take the same stain; some are darker than others.

ATYPICAL CELLS

I. Degenerated or moribund leukocytes. (1) A homogeneously stained mass looking like a washed-out, structureless nucleus that has lost its protoplasm and become ragged at the edges (karyolysis).

(2) The same intensely stained.

(3) Vacuolization of the neucleus or of the protoplasm.

In the granular leukocytes the granules are scattered about the field, and the neucleus is pale, structureless, and deformed.

II. Transitional neutrophile. Between marrow-cell and polymorphonuclear.

III. Turck's "stimulation forms." Described by Weil as nongranular myelocytes. They are associated with stimulation of the bone-marrow, grave anemia, and all conditions in which there is a leukocytosis.

PATHOLOGICAL CONDITIONS OF THE BLOOD

Classification. The following deviations from the normal may be observed:

1. Diminution in hemoglobin.
2. Increase or diminution in the red count.
3. Increase or diminution in the white count.

4. Alteration in color-index.
5. Diminution in the specific gravity.
6. Alterations in the size and shape of the red cells—i.e., poikilocytosis.
7. Alterations in the staining properties of the red cells—i.e., polychromatophilia.
8. Presence of abnormal forms of red cells.
9. Presence of abnormal forms of white cells.
10. Alteration in the normal ratio of different varieties of white cells.
11. Presence of parasites in the blood.

Polychromatophilia. With special stains certain of the red cells take on a darker color than the remainder of the cells, the tint varying with the stain used. This is due to a degenerative process, which changes the staining properties of the cells, so that they take up several colors.

Granular degeneration of red cells (Grawitz) **or punctate basophilia of red cells.** In certain diseases—malaria, lead-poisoning, severe anemia, etc., red cells often show small, bluish granules. These are well brought out by Wright's stain. The weight of evidence suggests that they are remnants of nuclei. Red corpuscles harboring malarial parasites often show these granules.

Abnormal forms of red cells—Nonnucleated: (a) microcyte—a very small red cell; (b) megalocyte—a very large red cell.

Nucleated: (a) microblast; (b) normoblast; (c) megaloblast; (d) atypical forms of nucleated red cells—called metrocytes by some authors.

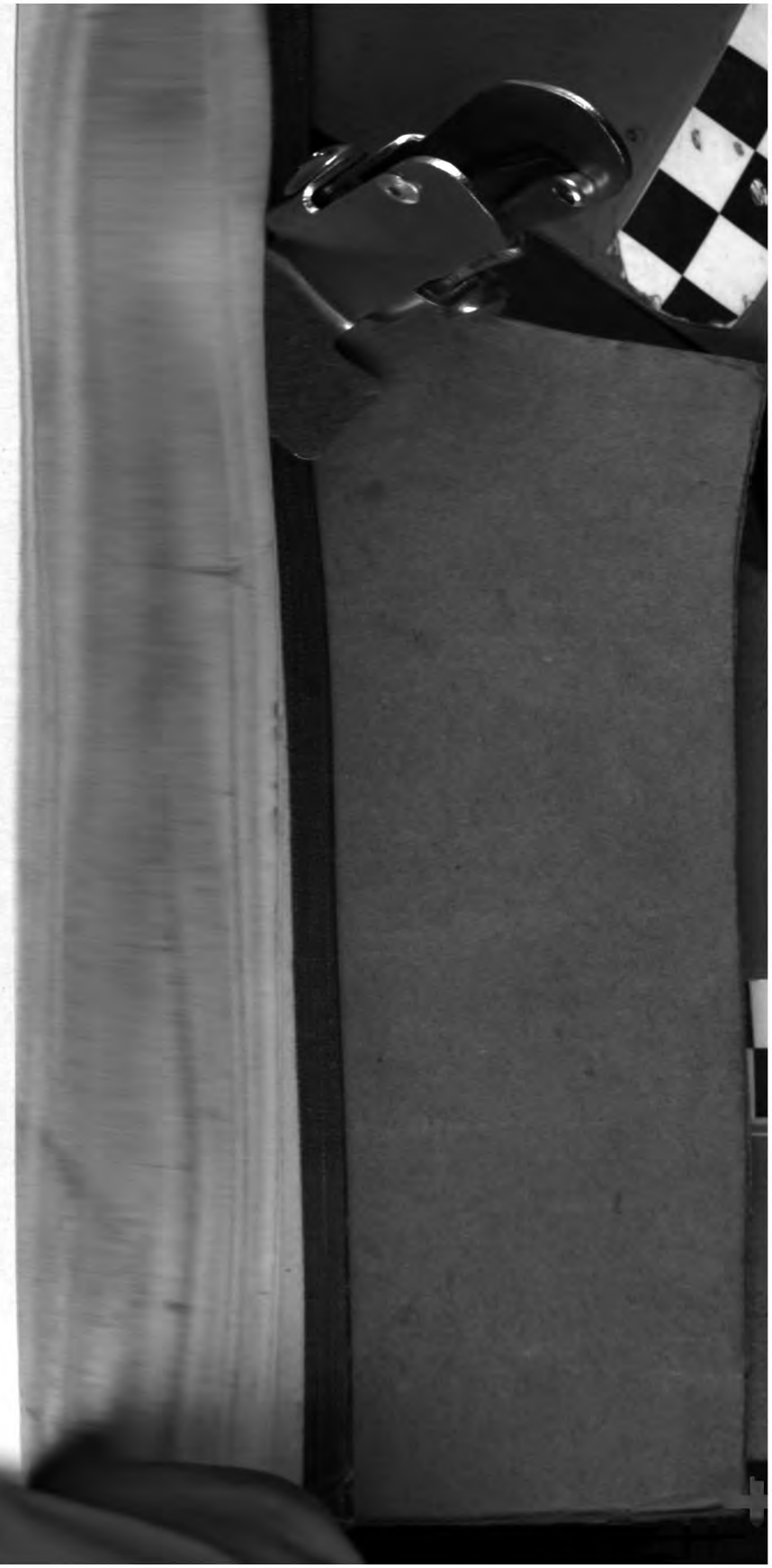
Microblast. A very small red cell, made up chiefly of a nucleus similar to that of the normoblast. There is a narrow rim of protoplasm around the nucleus. It has perhaps the same significance as the megaloblast.

Normoblast. It differs from the normal red cell in having a deeply-stained, round nucleus, about one-half the diameter of the whole cell, situated somewhat eccentrically. At times the nucleus is so situated that it looks as if the cell were extruding it.

Megaloblast. This does not occur anywhere in the healthy adult body. It is found in the early fetal marrow, and in the marrow and blood of grave forms of anemia. According to Ehrlich, the megaloblast indicates the presence of the fetal types of blood formation. It is a grave prognostic sign, and when present in excess of normoblasts it indicates a pernicious form of anemia. The only exception which clinicians have found to this view is the fact that the anemias due to intestinal parasites, and showing pernicious blood condition, may recover under appropriate treatment.

Megaloblasts may be found in milder forms of anemia, but the normoblast is the prevailing type. The typical megaloblast is a very large red cell, at times twice as large as the average (11 to 20 microns in diameter). Its protoplasm frequently shows marks of degeneration (polychromatophilia). The nucleus is very large and pale, filling most of the cell, thus contrasting greatly with the normoblast. It does not stain evenly, but has a mesh-like appearance, with darker and lighter areas. The entire cell reacts differently with Wright's, Ehrlich's triple, and the eosin-hematoxylon stains (see description of these stains). The cell may be circular, but is more often oval or somewhat irregular.

Myelocyte. This cell is a mononuclear neutrophile, and has many points of resemblance to the polynuclear neutrophile—in fact, it is the young form of that cell. It differs from the large lymphocyte chiefly in being larger and having neutrophile granules. Its nucleus is usually spherical or egg-shaped, and is in close contact with the cell-wall for a comparatively large portion of its circumference. Its average diameter is 15.75 microns.



Eosinophilic myelocytes. The myelocyte rarely shows eosinophile granules. The Ehrlich triacid stain alone differentiates the myelocyte from the large lymphocyte—by means of its granules. (Arneill.)

Coagulation of blood—Estimation of the time and completeness of coagulation. Normally clotting occurs in about three minutes, but in the exanthemata, in the various forms of the hemorrhagic diathesis, in obstruction of the biliary tract with or without jaundice, and in the various anemias it may be very much delayed.

Bogg's coagulometer (modified Russell and Brodie) consists of a glass cone inverted in a moist chamber, an air inlet through which air is blown at intervals by means of a rubber bulb. A small opening in the top permits the air to escape from the moist chamber. A drop of blood is placed upon the tip of the glass cone, which is then quickly inverted into the moist chamber. The air is then injected at intervals of a few seconds and the motion of the corpuscles is watched with the low power of the microscope. Coagulation is complete when motion ceases, or when cells spring back to original position when current of air ceases.

Wright's method. This method consists in the use of a set of from six to twelve capillary tubes (0.01 to 0.0125 inch in diameter), into which a column of blood is aspirated. The tubes are placed perpendicularly in a rack, and at regular short intervals the blood is blown from each one of them. When it becomes impossible to blow it out, coagulation has set in and the time is noted.

Hayden thinks he can distinguish between secondary and pernicious anemia by the incomplete formation of serum in the latter.

Widal test as an aid in the diagnosis of typhoid fever. (1) *Serum.* In hospital work, where a centrifugal machine is at hand; it is best to use blood-serum. It is obtained as follows: A piece of glass tubing (small bore) is drawn out to a fine point, and rubber tubing attached to the large end. One or two large punctures are made in the finger (which has been well massaged previously), the fine point of the tube placed in the drop and suction made with the mouth till considerable blood is drawn into the pipette. This is sealed by holding the pointed end in the flame of a match, and immediately centrifugated. The clot should be loosened around the edge to allow the escape of serum. A file-mark is made at the junction of clot and supernatant serum. With the finger over its top, break the tube and blow out the serum from the upper piece into a receptacle; or, probably a more satisfactory method is to use the Wright capsule. By sealing both ends of the capsule the contents will keep for some time. If a urotropin or hexamethylenetetramine tablet is balanced on its edge on a coin and ignited, it will give sufficient heat to seal the capsule, and is a very handy substitute for an alcohol lamp at the bedside. If desired, dilutions without limit can be made with this serum as follows: One drop is placed in a small glass dish or on a slide and nine drops of salt solution added, giving a dilution of 1 to 10. A dilution of 1 to 20 is obtained by taking one drop of this 1 to 10 dilution and adding to it one drop of salt solution. A dilution of 1 to 40 is obtained by taking one drop of the 1 to 10 dilution and adding to it three drops of diluting fluid, etc. The same pipette must be used for measuring the drop of serum and the water in order to secure accuracy.

Whole blood method. In private practice this is more easily carried out than the above.

(1) An accurate dilution of 1 to 10, 1 to 20, or 1 to 40 can be made with a white-blood counter, using distilled water as a diluting fluid.

(2) A convenient and easily applied method (especially if the preparation is to be sent by mail) is to allow a good-sized drop to dry on a cover-slip or glazed paper. If paper has been used, cut out the blood-drop and place in a test-tube containing two drops of water; by agitating it the blood will dissolve. To obtain a dilution of 1 to 10, eight drops of water or bouillon are added.

The culture of the typhoid bacillus. A young—eighteen to twenty hours old typhoid culture is required; it must be actively motile. It may be grown on agar or in peptone bouillon, in the thermostat at 37 degrees C. The disadvantage of the bouillon is that the growth is often very small. Stock cultures are grown on agar at room temperature, and are transplanted about once a month.

Actively motile cultures show the clumping best.

Preparation of specimen for microscopical examination. A drop of the blood or serum diluted, 1 to 10, is placed upon a cover-glass. Mix it (thoroughly, to separate bacilli) with a bouillon culture of the typhoid bacillus to desired dilution; as one drop of each (serum and bouillon) equals a 1 to 20, one of serum, and three of bouillon equals 1 to 40 dilution, etc. A concave slide, with vaselin, is placed upon the cover-glass, thus giving a hanging drop, and the preparation immediately examined under the microscope. A control slide should be made with distilled water for comparison. The preparation should now be carefully examined every few minutes for loss of motility and signs of clumping. The length of time for the development of this phenomenon should be noted.

Instead of the bouillon culture a suspension made from fresh agar culture mixing well with a little salt solution) may be used. The drop should be examined at beginning of test to be sure that there is no clumping.

THE MICROSCOPICAL EXAMINATION OF FECES

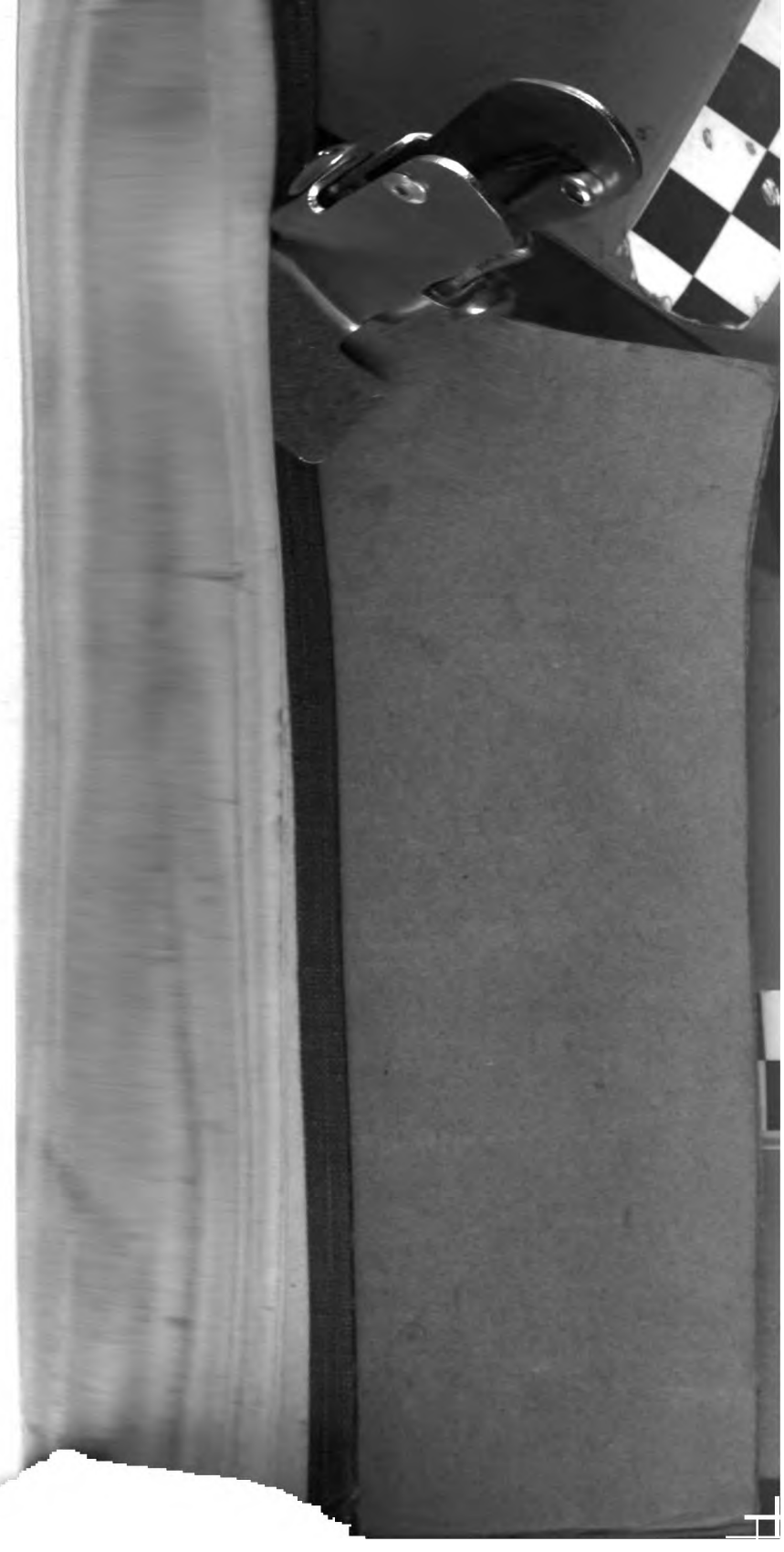
The "three drop" method described under gastric analysis is useful. Preparations must be made very thin. If the stool as passed is firm, it may be diluted with normal salt solution.

Thin smears may be made on cover slips, dried and stained by Unna's polychrome methylene-blue, Gram's stain or Smithies' colored-agar method. It is best to examine stools for parasites unstained.

Among the common pathologic findings are—undigested food, especially meat and fat (pancreatic disease), blood, pus, mucus, Oppler-Boas bacilli (cancer of stomach), yeasts and sarcines (gastric or intestinal stagnation of benign type), tissue bits (malignant cells in cancer of large bowel), crystals (hemin, triple phosphate, leucin, tyrosin, cholesterin, fatty acid), moulds, torulæ, leptothrix and intestinal parasites, particularly protozoa.

Varieties of parasites. The common intestinal parasites in the middle-west are:

I. *The Cestodes* (tape-worms).
   (a)—*Tænia saginata* (common tape-worm).
   (b)—*Tænia solium* (from measly pork).
   (c)—*Tænia nana* (dwarf tape-worm—common in children).
   (d)—*Bothriocephalus latus* (Russian tape-worm, causing marked anemia).
   (e)—*Tænia echinococcus.* (Contracted in man from food or association with dogs or sheep.)



II. *Strongylidæ* (round worms).

(a)—*Ankylostoma duodenale*—or hookworm. *(Necator Americanus.)* (Found in small intestines especially in people south of the "Mason and Dixon line." Causes anemia and characteristic physical changes.)

(b)—*Ascaris lumbricoides.* (The most common parasite of man, especially children. Inhabits small intestines, may be vomited up.)

(c)—*Oxyuris vermicularis* or "pin or seat" worm of children. (Very common; male 1/6 inch long and female ½ inch long. Male has a curved tail. Mature in cecum and colon and then wander to rectum, working out about anus at night. May enter vagina or urethra or get beneath prepuce.)

III.

(a)—*Trichomonas.*—Common in intermittent diarrhea in patients who have drunk contaminated well water, or eaten contaminated vegetables, fruits, etc. This parasite has a pear-shaped body about 18x10 microns. Three (often four) flagella arise from anterior end. There is a lateral undulating membrane.

(b)—*Cercomonas.*—An organism similar to the above, but with no flagella or undulating membrane. It is found under similar circumstances.

(c)—*Balantidium coli.*—A common parasite of hogs and not infrequently associated with periodic or chronic diarrhea of people residing in rural communities. It is from 60 to 100 microns long and 50 to 70 microns broad. The organism has a peristome at its anterior end, and a row of cilia almost encircling the ectosarc.

IV. *Rhizopoda* (should be identified by an expert).

(a)—*Entameba coli.*—Common concomitant infection in chronic diarrhea. Said not to be pathogenic, but this is disputed.

(b)—*Entameba histolytica.*—Pathogenic ameba and associated, apparently casually, with acute and chronic diarrhea.

It is of the greatest importance for the surgeon to be familiar with these intestinal parasites and to look for them in cases coming under treatment for any one of a number of unusual conditions, or for anemia, dysentery, digestive disturbances, in order that the patient may not be exposed to a useless or harmful operation, which can be avoided by removing the parasites or their original cause.

GENERAL PREPARATION OF THE PATIENT

In this systematic examination many things are considered which may not have any bearing upon any given case in question, but when applied to all the cases in practice each point is of more or less importance.

Of course, the systematic analysis of cases must not be supposed to render superfluous the judgment and practical experience of the surgeon or physician who makes the examination. A thorough system, good judgment, and a wide experience will result in the accomplishment of benefit to the patient when they are employed simultaneously.

After all of the circumstances present in the case have been determined the necessary preparations for the operation may proceed.

Concomitant diseases. If there exists serious disease of one of the important organs, aside from the condition to be relieved by the operation, i. e., if the

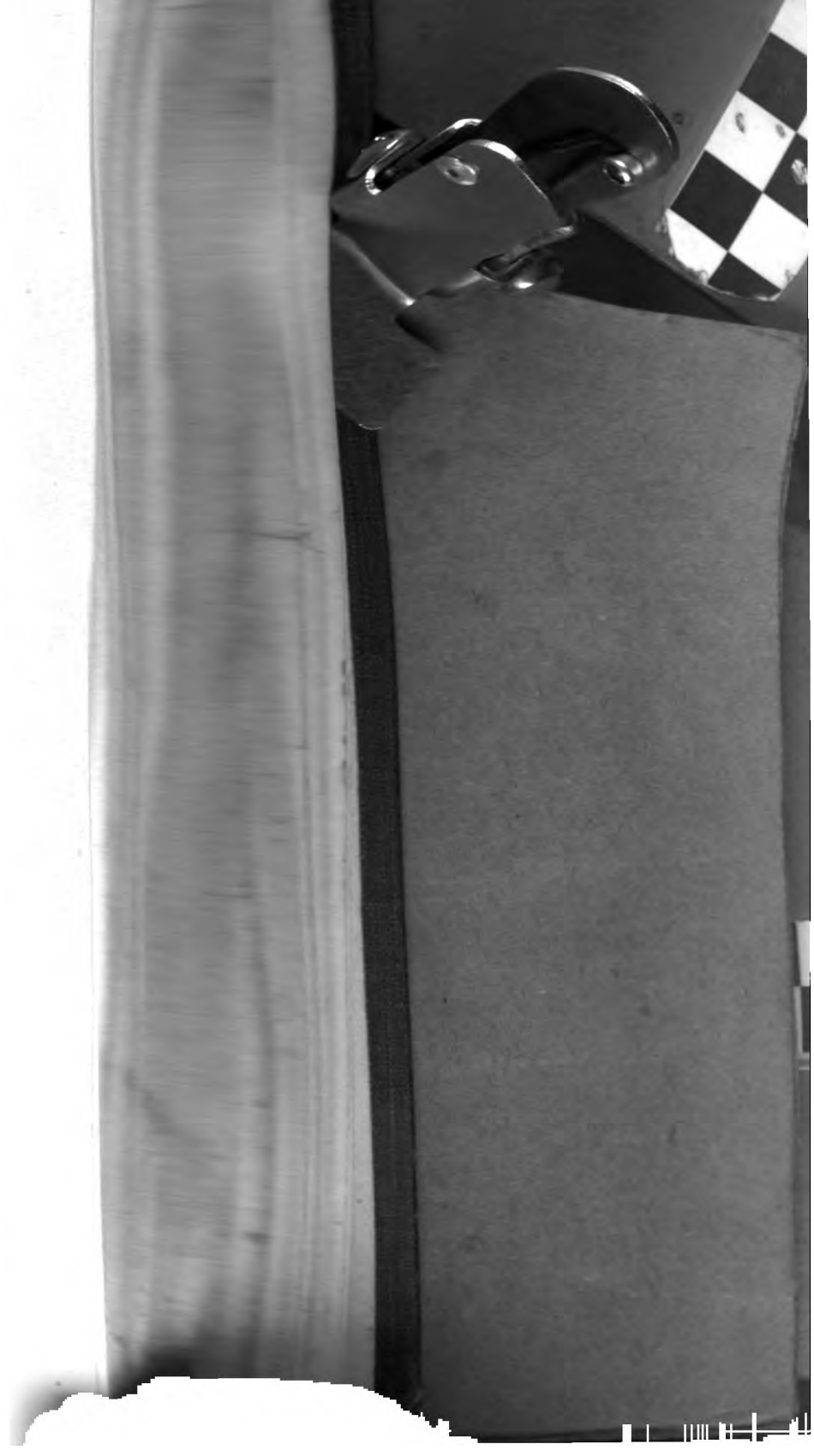
bloodvessels, heart, lungs, kidneys, liver, pancreas or spleen, or the blood itself, be seriously impaired, it is well to overcome such fault unless it is directly the result of a condition which is to be relieved by the operation itself and will probably improve much more rapidly after than before the operation. This is especially true in patients suffering from anemia. It such anemia depends upon a loss of blood which will be stopped by the operation, then the recovery will usually be exceedingly rapid after the operation has been performed; if due to other causes the patient's recovery will be very slow unless the anemia is relieved before the operation is done. If no important organ is seriously impaired it is much better not to worry the patient unnecessarily before the operation. As a rule, long-continued preparatory treatment leaves the patient in a much less favorable condition for a surgical procedure than a very short and simple preparation which serves to put the kidneys, the skin and the alimentary canal in a state favorable to the elimination of the waste products.

The day before operation. During the day before the operation the patient should be kept on light diet, consisting of sterilized food, preferably broth or gruel, and allowed an abundance of good water, preferably hot, in order to favor elimination through the kidneys. A non-irritating cathartic should be given and, if possible, a warm bath. For several years we have given, as a rule, two ounces of castor oil in the foam of beer or malt extract the day before an operation, and a large soap and water enema, or one consisting of normal salt solution, on the morning of, or on the evening before, the operation. In this manner the patient is relieved in a relatively short time of much waste matter and is consequently removed from the likelihood of absorbing the products of decomposition which may be present in the alimentary tract. We have found that so large a dose of castor oil is borne perfectly by almost all patients, and that it does not give rise to disturbance, pain or exhaustion. We have also found that foam of beer or malt extract disguises the oil so thoroughly that those who are ordinarily nauseated very readily will bear this method without annoyance.

Prolonged preparatory treatment condemned. In the vast majority of patients this amount of preparation suffices to relieve the body of any burden it may possess which might interfere with the progress of healing, or the normal course of convalescence. In other words, the patient approaches the operation in a comparatively clean condition; his strength has not been impaired by confinement and his nervous system has not suffered by looking forward to the operation for a long time. Some years ago we had the opportunity to observe the effect of waiting for a number of days, and sometimes for several weeks, to allow the patient to get into a more favorable condition for operation, and we are positive that as a rule the practice is bad. The exceptions are in those patients in whom the heart, the kidneys or the blood are too seriously impaired, and who might be placed in a better state by waiting; and in cases in which infection is present which may become circumscribed or may be eliminated by delay.

We will refer to these conditions again in connection with patients in whom they are present; and will especially refer again to old age, because elderly patients bear many operations remarkably well if they are not confined before, and only for a short time after, the operation, while quite the opposite is true if this precaution is overlooked.

Transfusion of normal blood. In patients suffering from anemia, especially secondary, it is often of great importance to improve the condition of the blood by direct transfusion of normal blood, particularly if the patient's per-



centage of hemoglobin is very low and if the character of the blood shows that there has been a great loss or a great destruction of important elements. The necessary precautions and the method advised will be discussed in a special chapter on transfusion of normal blood. The time and quantity must depend upon the condition of the patient.

If the hemorrhage has stopped it is usually well to make a transfusion and await the effect. If the blood improves from day to day the operation may be postponed, if not, it is well to make a second transfusion just before beginning the operation (to which the transfusion is preliminary) and just after concluding it. The question of amount, selection of donor, etc., will be discussed later.

THE FIELD OF OPERATION

Immediate preparation sufficient. In hospitals where many operations are performed on the same day, so that the time spent upon each case, immediately preceding an operation, is of importance, it may be well to prepare the field of operation on the day before, but this is done simply as a convenience, and not because it is better than it would be to prepare the field of operation immediately before beginning to operate. For months at a time we have followed the latter plan without having a single wound infected, and other surgeons have had the same experience, hence there can be no good reason for insisting upon having the field of operation prepared one or more days before the operative procedure. However, this may be done as a matter of convenience.

Details of surface preparation. The important point in preparing a surface for operation lies in thorough washing with soap and water; anything that is accomplished beyond this is of little importance, provided the washing process has been done carefully and thoroughly. In our practice the steps taken in preparing the field of operation are as follows: 1, Thorough scrubbing with soft soap and warm water with a moderately stiff brush; 2, Washing the surface with a piece of aseptic gauze saturated with fresh water, because the epithelial scales which have been loosened with the brush are easily removed in this manner; 3, Soaping and shaving the field of operation; 4, Washing again with aseptic gauze and sterile water; 5, Washing the surface with commercial, i. e., about ninety-five per cent., alcohol; 6, Washing with a solution of corrosive sublimate, one part in two thousand.

In many instances only the first four, or the first five, steps were taken and always with the same results, consequently we are confident that careful washing of the surface with soap and water is the important part, but as there can be no harm in the other two procedures they might as well be taken, so long as it is convenient in any given case.

Use of antiseptic fluids. There is still a distinct superstition in favor of the use of some antiseptic fluid for washing the field of operation, and so long as the fluid employed is harmless we believe that we are justified in using it. If this preparation is made just before beginning the operation it will suffice; if made on the day before the operation the surface must be protected against re-infection during the interval, which can be done by applying sterile gauze or cotton to the surface and holding it in place by means of a carefully applied bandage. On the following day the surface is once more washed with a piece of sterile gauze saturated with alcohol and is then ready for operation.

Avoid skin irritation. It is important not to irritate the skin by the violent

use of a stiff brush or the careless use of the razor, and care should be taken to have the razor sterilized. It is an easy matter to irritate the skin during vigorous or violent preparation to such an extent that the micro-organisms normally contained therein will be forced into activity, making at least a slight infection certain to occur.

It is much better simply to wash the field of operation very gently with soap and warm water with a soft piece of gauze than to use any method, however thorough it may seem, which will leave the skin in an irritated condition.

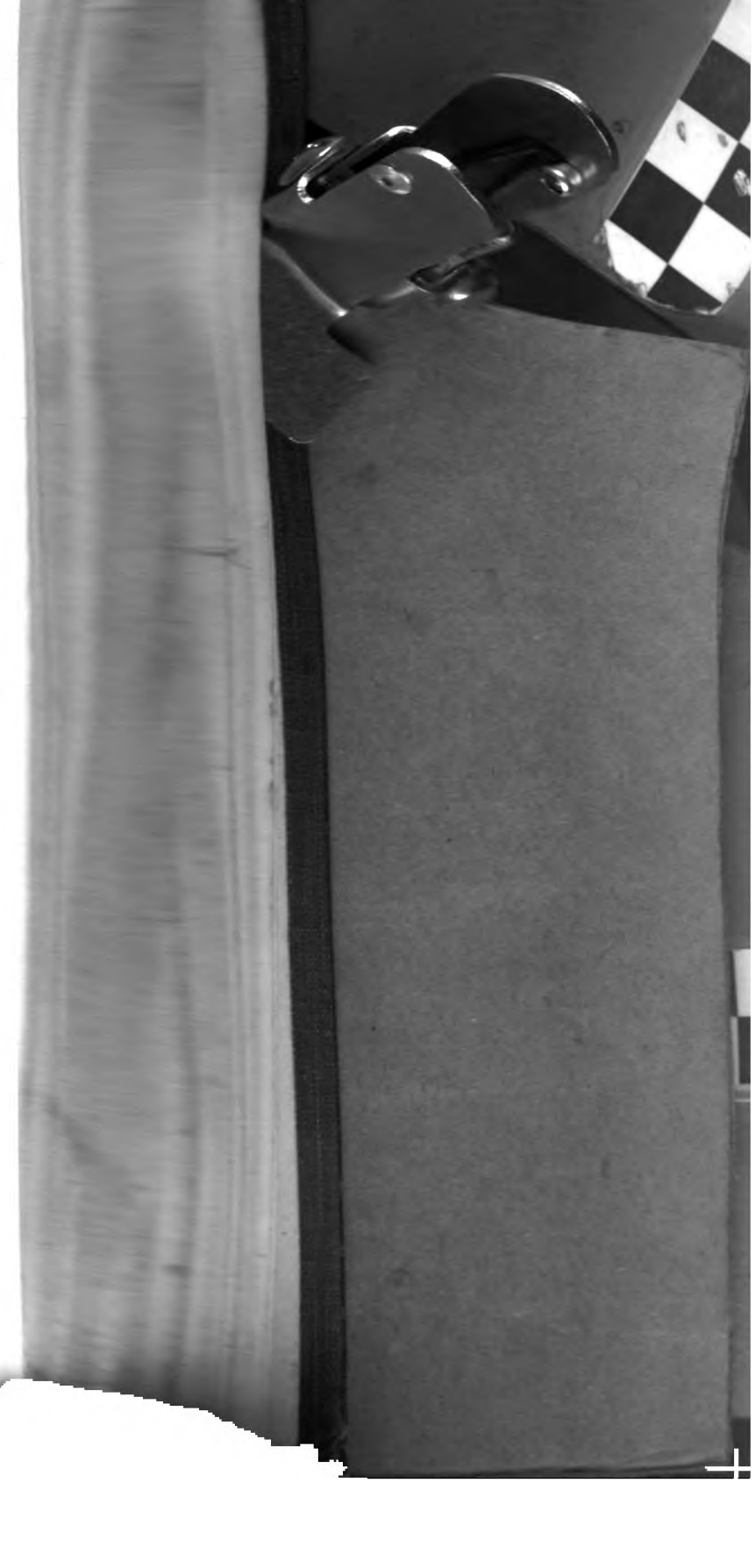
Sterile towels about the wound. In order to prevent infection of the field of operation from any of the adjacent surfaces, it is well to lay four sterile towels around the part and hold them in place by means of safety pins, or better still by the use of forceps with sharp, beetle-like mouths which will grasp the towels, together with a little of the underlying skin, and will thus prevent slipping of the towels. The space exposed should be large enough so that the towels need not be shifted during the operation, because such an act is likely to cause infection by carrying micro-organisms on the under surface of the towel from adjacent portions to the field of operation. During the operation these towels should be left in place, and in case of becoming soiled they should be covered with fresh towels, but otherwise they should not be disturbed or removed. Again, when the operation has been completed the greatest care should be exercised to protect the wound while these towels are removed. This can be done very easily by placing a piece of moist, aseptic gauze over the entire surface of the wound and leaving it in place until all the necessary disturbance has been completed, then carefully sponging the surfaces around this pad, and at last removing the pad and covering the wound with proper dressings.

Avoid infection from surrounding parts. During the operation it is best to handle the tissues as little as possible, and to do this with instruments as much as may be, and as little as possible with the hands, and never to manipulate the patient's skin first and then the wound, because the epidermis almost always contains some micro-organisms which might be transferred to the wound.

A practice which should be guarded against consists in first sponging all about the wound and finally the wound itself. If the skin about the wound be sponged at all, the same sponge should not be used in or upon the wound thereafter.

Tincture of iodine in crushed wounds. Recently a method of disinfection of the field of operation with tincture of iodine has been recommended by Grossich, which has the excellent qualities of being simple, convenient, safe, efficient and generally applicable. The method has been further developed and perfected by Bogdán, whose plan is worthy of adoption, especially in cases which have sustained severe crushing injuries in which the method described above is not altogether satisfactory because in scrubbing the areas surrounding the wound much of the dirt is certain to drain into the wound during the process of disinfection, and it is questionable whether the harm which will be done by this soiling of the wound is not greater than the benefit derived from the disinfection.

Iodine and benzine. Bogdán's method consists in making a solution of one part of iodine crystals in one thousand parts of benzine, which can be readily accomplished by adding one drachm of iodine crystals to the gallon of benzine or one gram to the litre.



The entire area to be disinfected is carefully shaved dry in case the portion of the body is covered with a perceptible growth of hair. It is then rubbed off carefully with pledgets of sterile gauze saturated with this fluid. This is repeated several times, the disinfection of a large area consuming not more than two or three minutes. When the benzine has evaporated the entire surface is painted repeatedly with tincture of iodine, also for a period of about two minutes, pledgets of sterile cotton being used for this purpose. As soon as the alcohol contained in the tincture of iodine has evaporated, leaving the area perfectly dry, the operation may begin. This method has proven most satisfactory and may be employed as well in other than traumatic cases, although in non-traumatic cases there is not the same necessity to vary from the method described at the beginning of this section.

Caution in use. In these cases the patient should be given a thorough soap and warm water bath on the day before the operation, and the operative area should be soaped and shaved and again washed with warm water in order to reduce the time necessary for preparation on the day of operation, when the remaining steps in the process of disinfection described above should be carried out. It is important to bear in mind that the use of benzine is extremely dangerous in the presence of gas-light or fire of any kind, consequently, in preparing the field of operation, quite as much care should be taken when this method is employed as when ether is used.

As this is always undertaken by thoroughly trained nurses or physicians, the danger is not really very great if their attention is directed to this factor.

PREPARATION OF THE SURGEON'S HANDS

What has been said concerning the preparation of the field of operation applies very closely to the care of the operator's hands before an operation.

Details of hand disinfection. The important point is to make sure of careful, thorough washing with soap and sterile water, then cleansing the space underneath the finger nails, then washing again, first with a moderately soft brush and then with a piece of gauze. We have found it an advantage to wash in a deep basin full of warm, sterile water, keeping the hands under water while scrubbing with the brush and washing with the gauze pad, and then to wash in sterile running water after the hands have been thoroughly scrubbed underneath the soap suds.

Smooth skin. It is important above all things to keep the skin upon the hands smooth and soft, and not covered with grooves and crevices. If the surgeon's skin is smooth it is much easier to keep the hands aseptic than if it has been roughened by the use of strong antiseptic solutions. There is a great difference in the skin of the hands of different surgeons, and consequently it is wise for each one to avoid the antiseptic solution which happens to be harmful in his case; and if all solutions have the same effect, it is wise simply to wash with soap and sterilized water, because smooth hands can be rendered perfectly safe in this way, while rough hands cannot be made safe by the additional use of any one of the various antiseptic solutions which have been recommended.

Even the employment of certain varieties of soap has a ruinous effect upon the hands of some surgeons, but with them it is always possible to determine experimentally what variety of soap has this harmful effect and by changing the ingredients so as to neutralize the substance which gives rise to

the irritation it is practically always possible to overcome this difficulty. Should the hands, however, become roughened notwithstanding the exercise of all of these precautions this can usually be overcome readily by systematically caring for the hands at the end of the day in order that during the night's rest the skin may recover from the day's irritation.

To overcome roughness of the hands. The hands should be washed before retiring with a soft cloth in a deep basin filled with exceedingly hot water to which a sufficient amount of non-irritating soap has been added to make it smooth, or in case all soap causes irritation, bran may be added to the water. The water should be just as hot as can be borne and the washing should be continued for several minutes until the hands are thoroughly hot. Then they should be plunged into cold water, that is, having the ordinary temperature of the water supply in most cities. After a minute the hands are to be dried and anointed with lanoline and covered for the night with soft chamois skin gloves. In most instances this course will entirely and speedily overcome the roughness of the skin.

In our own practice we follow the washing with soap and water by the use of strong alcohol, and then a solution of corrosive sublimate, one to two thousand.

Avoid pus. In hospital practice there are certain other precautions which are of exceedingly great importance, largely in the way of prophylaxis, which will aid greatly in securing aseptic conditions. The most important of these is to keep the hands out of pus. In dressing suppurating wounds either forceps or rubber gloves should be used, so as to prevent the hands from touching pus. Operations should be performed early in the morning, before any one connected with the wounds has done any dressings. Puddling in pus is pernicious practice. This fact should be impressed most forcibly upon every one connected with the work.

Aseptic cases should always be operated first, and later those containing pus. In operations upon suppurating cases rubber gloves are used at the present time, but in former years, by taking the precautions indicated above, practically no infections took place, although no gloves were worn.

Antiseptic conscience. The same precautions should be taken in dressing the wounds—no suppurating wounds being dressed until all the clean wounds have been finished. Every evening before retiring the surgeon and all the assistants should scrub their hands with the same care that is employed in disinfection before an operation. It is absolutely necessary for every one connected with surgical work to develop an antiseptic conscience, because upon this depends the condition of the wounds rather than upon any special method.

It is a comparatively easy matter to secure an aseptic condition of the hands before the operation, but it requires great vigilance on the part of every one associated with an operation to maintain this condition throughout the procedure. Unless each has an antiseptic conscience some one is likely to touch something which is not surgically clean and transfer the infectious material with his hands to the wound. In order to become thoroughly impressed with the ease with which this can be accomplished, every surgeon should take a practical course in a bacteriological laboratory extending over a number of months, because the same carelessness which will ruin a culture plate may cause a wound infection, and one really cannot fully appreciate how easily this occurs until after having had the experience of ruining a lot of pure cultures in bacteriological experimentation.

RUBBER GLOVES

If a surgeon has not a smooth, pliable skin, or if for any reason it seems difficult to obtain perfectly clean hands by washing, or if he has recently touched infected wounds, or performed autopsies, or dressed suppurating cases, it is well to protect the patient to be operated by wearing aseptic rubber gloves.

Objections. It should, however, be borne in mind that the surgeon loses much in dexterity in this way, and being deprived of the finer sense of touch his skill is quite materially impaired, and in some very delicate operations this impairment may be sufficient to deny the patient the slight chance he had of surviving the operation or receiving the best results therefrom. Of course, this would apply to only a small proportion of all the patients operated upon, but it is large enough to be worthy of consideration.

It is quite different with the hands of assistants and nurses connected with operations. These can perform the less delicate duties which are entrusted to them as well with gloves as with bare hands, and consequently the additional safety which comes from covering their hands with aseptic rubber gloves is of sufficient importance to recommend their use.

Details of use. In using gloves it is of the greatest importance to disinfect the hands with the same care as when no gloves are used, because a glove may tear or become punctured at any time during an operation. If this happens the glove should be discarded at once, as a torn glove is necessarily much more dangerous than no glove at all, its warmth and moisture having a tendency to loosen the epithelium which may contain pathogenic micro-organisms.

Confirm necessity for gloves. It is important for each individual surgeon to determine definitely whether or not it is possible for him to absolutely disinfect his hands. This can be done easily by taking scrapings from his fingers, especially from portions underneath and at the base and sides of the finger nails. If a surgeon's hands contain micro-organisms after he has disinfected them, then it will not be safe for him to operate without wearing rubber gloves. There is such a vast difference between the hands of different surgeons that a rule for the disinfection of the hands of one cannot properly apply to others without confirmation by carefully carried out bacteriological tests. All in all the advantages of using rubber gloves outweigh their disadvantages to such an extent that as a rule it is better to employ them, although this cannot be considered absolutely necessary.

DISINFECTION OF INSTRUMENTS

All instruments, except knives, should be boiled for half an hour in a solution of a tablespoonful of baking soda to the quart of water before they are put away after operations, and again before they are used. The knives are washed carefully with pads of sterilized cotton, saturated with alcohol before and after using.

DISINFECTION OF SILK, SILKWORM GUT, HORSE-HAIR, DRAINAGE TUBES AND BRUSHES

This is accomplished by boiling in water for one hour, and preservation in five per cent. solution of carbolic acid in water, or in strong, commercial alcohol, until used.

Method of preparing and preserving catgut. Catgut is prepared by immersing in sulphuric ether for one month, then for one month in strong, commercial alcohol, in which one grain of corrosive sublimate to the ounce has been dissolved, the solution being renewed once during this time. It is then preserved indefinitely in a solution of one part of iodoform, five parts of ether and fourteen parts of strong, commercial alcohol. In this solution catgut may be preserved with perfect safety for many years in jars which prevent the evaporation of the ether. The loss of ether from the jars which are opened occasionally for the removal of catgut to be used from day to day may be made good by adding ether occasionally when it is noticed that iodoform is becoming precipitated at the bottom of the vessel.

It is not necessary to be accurate concerning the amount of ether replaced because an excess in no way injures the catgut. The entire substance of the catgut becomes thoroughly permeated with fine crystals of iodoform, which remain in the suture until the last portion of catgut fibre has been absorbed. This is a marked advantage over catgut saturated with iodine in which no trace of this antiseptic can be found two days after the introduction of the buried suture. It should never be handled by any one except the surgeon and the chief assistant. This catgut will last seven to ten days in tissues, according to the size used. It is employed in all ligatures, both in the peritoneal cavity and elsewhere, and for all buried sutures except in hernias and in the suturing of bones. For these purposes a chromicized catgut is employed, which lasts from fifteen to thirty days, according to size. This is prepared after the following formula: The catgut is immersed in ether for one month, then in a solution prepared in the following manner:

Chromicized catgut.

A. Chromic acid ..... 1 part.
Water ..... 5 parts.
(Carefully dissolve.)

B. Take of solution A ..... 1 part.
Glycerine ..... 5 parts.

Take solution B and soak therein catgut for forty-eight to ninety-six hours, according to resistance wanted. Forty-eight hours will resist absorption by tissue for fifteen days: ninety-six hours will resist for thirty days.

C. Take catgut out of solution B, rinse quickly in sterilized water to free it from solution B, stretch and rub quickly with a hard, sterile towel to remove any of the solution B which may still be adhering to it, wind on rods, or slides at least three inches in length and preserve indefinitely in the following solution:

D. Carbolic acid, 95 per cent ..... 1 part.
Glycerine ..... 5 parts.

The catgut may remain in this solution for many months without depreciating in quality, or it may be kept for an indefinite period of time in the same solution as the ordinary catgut, composed of:

Iodoform ..... 1 part.
Ether ..... 5 parts.
Strong alcohol ..... 14 parts.

The jar containing the ether in which the catgut is kept for one month should be filled only about one-half with the loose coils of catgut and then it should be filled with ether; it should be closed air tight and should be picked up every day or two and shaken in an inverted position in order to wash off any substance which may accumulate upon the surface of the coils. At the end of two weeks the ether should be removed and fresh ether substituted.

The same precautions should be taken with the solution of corrosive sublimate in alcohol.

It is especially important not to wind the catgut tightly before placing it in these solutions, because this may prevent the solutions from penetrating all parts of the material.

One precaution is necessary in the employment of catgut which has been prepared in this manner; it must not be placed in water before it is used at the time of the operation.

It seems that the iodine which is absorbed by the catgut in the iodoform-ether-alcohol solution makes it slightly antiseptic, which is probably an advantage.

Upon splitting a piece of catgut which has been preserved in this fluid and permitting it to dry it will be found that the entire substance is permeated with fine crystals of iodoform which will be absorbed no more rapidly than the catgut itself, thus making the latter slightly antiseptic until it is entirely absorbed.

This seems to be of importance especially in the use of chromic gut because of the length of time it normally remains in the tissues.

These two methods are so simple that they can be carried out as well in the simplest office of the country practitioner as in the laboratory of a well-organized hospital.

Experience results. We have personally used catgut prepared in this manner in more than twenty-five thousand operations, and the fact that we have adhered to this method of preparation, while we have changed almost every other detail in antiseptic technique in the meantime, shows that this very simple method must be satisfactory.

Catgut infection. Observations have convinced us that what is ordinarily known and feared as catgut infection is quite unnecessary and that it depends upon one or more of five conditions which can easily be eliminated, viz.: 1, Commercial catgut which may not be reliable; 2, Catgut that has been saturated with antiseptic substances which cause a necrosis of the tissues included in the suture or ligature; 3, Pressure necrosis due to tying the stitches too tightly; 4, Infection of the catgut by careless manipulation by the surgeon or his assistants, the suture or ligature being permitted to touch objects not sterile; 5, Infection of the catgut by the septic hands of the surgeon or his assistants.

PRESSURE NECROSIS

Although drawing sutures or ligatures tightly enough to cause pressure necrosis cannot produce infection by itself, this is, nevertheless, a very common, if not the most common, cause of what is termed "catgut infection," inasmuch as this furnishes a very favorable culture medium for any accidental infection which may occur during the operation and which would not develop into suppuration were not the tissues impaired by the constriction due to the undue tension placed upon the stitches or ligatures.

It has seemed to us that much of the improvement in aseptic results which many surgeons have attributed in their practice to the use of rubber gloves must be due to the fact that the wearing of gloves which have an exceedingly smooth surface has prevented them from tying their stitches and ligatures too tightly and that this explains the decrease in the amount of catgut infection in their experience.

This point is so important that we shall refer to it again in connection with the various operations in which its neglect is especially likely to cause mischief.

Importance of safe catgut. We have spoken at length concerning catgut, because if properly prepared and used it is certainly an ideal suture and ligature material, and it is important to have this material so that it can be invariably relied upon. Undoubtedly some manufactures furnish catgut in a condition in which it can always be depended upon, but it is difficult to ascertain which of these firms are reliable, consequently it is best for each surgeon to prepare his own material. In large hospitals this can, of course, be delegated to a dependable person who is permanently employed and who fully comprehends the importance of his task. It is not well to assign assistants who frequently change their service to undertake this work, because then it is impossible for the surgeon to fix the responsibility.

IODINE CATGUT

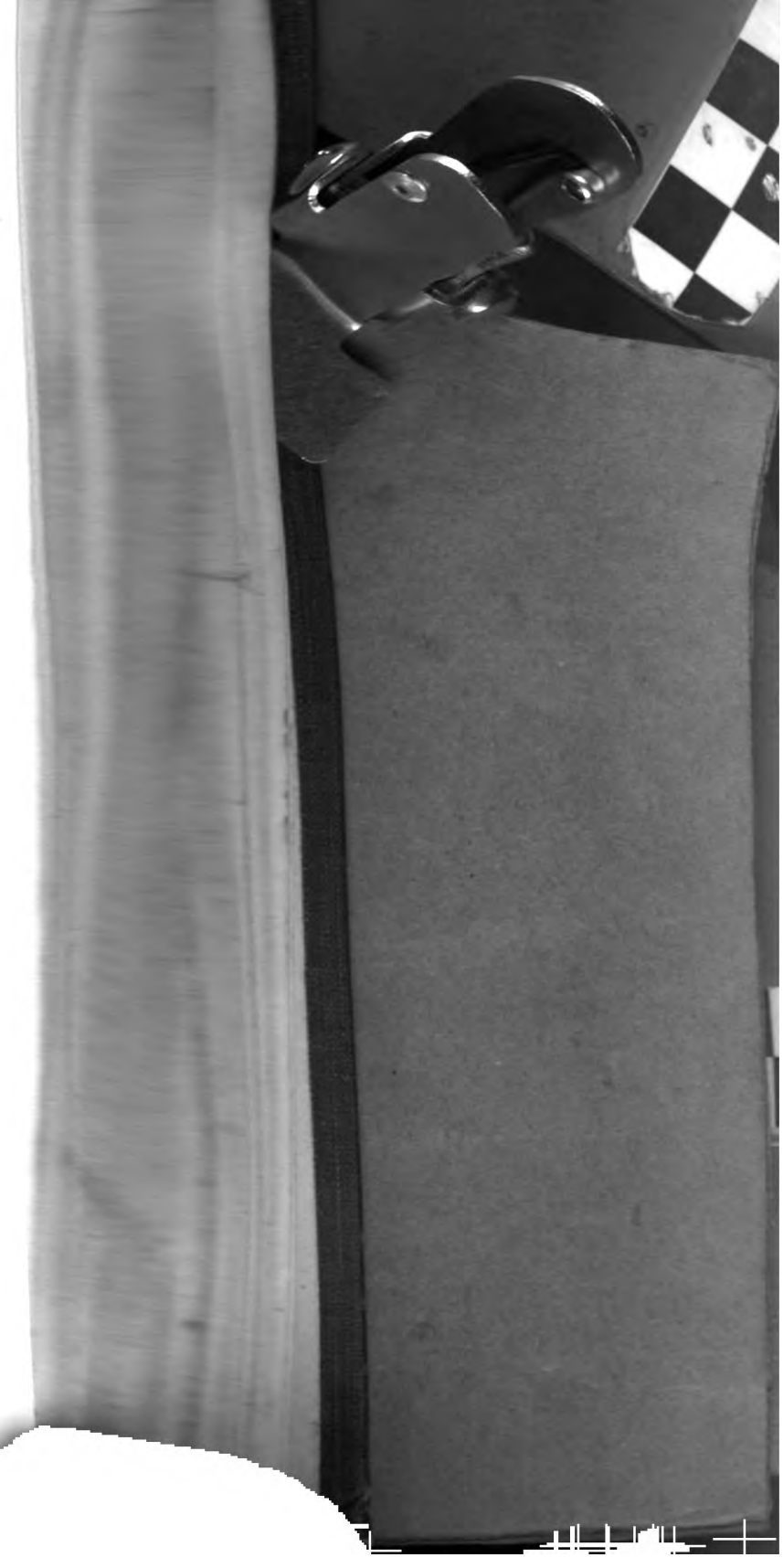
Catgut impregnated with iodine has been in use for a number of years and has given excellent satisfaction to those who have employed it constantly. The presence of this antiseptic material seems to increase the safety of the suture or ligature substance because it may serve to destroy any micro-organisms which may have been introduced accidentally during the operation. However, the especial value of this method lies in its simplicity and in the fact that the tensile strength of the catgut is but slightly impaired by the process of preparation. The fact that the iodine is entirely absorbed long before the catgut disappears makes this suture material slightly less desirable to use than that prepared by the method described above. It is, however, possible to preserve this suture material indefinitely in the same iodoform-ether-alcohol mixture that we use for the catgut already described if the catgut is first carefully prepared by the iodine method, especially if the most excellent process invented by Willard Bartlett, of St. Louis, is chosen.

Willard Bartlett method of preparing. In order to secure uniformly satisfactory results it is important to carry out the various steps laid down in the following description of the method with the utmost accuracy, because if any change is made in these steps the catgut is likely to become somewhat hard or brittle. It is also important to remember that the method must never be attempted in wet weather or in a room containing steam or moisture.

"1. The strands are cut into convenient lengths, say thirty inches, and made into little coils about as large as a silver quarter. These coils in any desired number are then strung like beads onto a thread so that the whole quantity can be conveniently handled by simply grasping the thread.

"2. The strings of catgut coils are dried for four hours at the following temperatures: 160, 180, 200, 220 degrees, one hour each, the changes in temperature being gradually accomplished.

"3. The catgut is placed in liquid albolene, where it is allowed to remain



until perfectly 'clear,' in the sense that the term is used in the preparation of histological specimens. This is usually accomplished in a few hours, though it has been my custom to allow the gut to remain in the oil over night.

"4. The vessel containing the oil is placed upon a sand bath and the temperature raised during one hour to 320 degrees F., which temperature is maintained for a second hour.

"5. By seizing the thread with a sterile forcep the catgut is lifted out of the oil and placed in a mixture of iodine crystals one part in Columbian spirits (deodorized methyl alcohol) one thousand parts. In this fluid it is stored permanently, and is ready for use in twenty-four hours; the thread is then cut and withdrawn.

"It seems to me important that the gut should be thoroughly 'cleared' before the oil is heated, in order that we may thus be certain that the temperature of the center of the strand becomes as high as that of the oil outside. It may be noted further that I do not remove the oil from the gut before placing it in the storing solution. This is done purposely, since catgut which is perfectly free from oil is so very sensitive to the action of water that it readily untwists and becomes tangled after it is used in a wound but a few moments. This storing fluid simply takes off enough oil from the exterior of the strand so that it is not too slippery for use, and the albolene being a bland, non-irritating substance, there is no reason why it cannot be safely left in the gut. The iodine rapidly permeates the strand; the same will be found stained black after a few hours, and consequently the surgeon will have the assurance that he is introducing an antiseptic as well as a thoroughly sterile suture material.

"As far as the tensile strength and pliability of the finished product are concerned, I may state that this leaves nothing to be desired. I have made a large number of breaking tests, and have found no other heat method to produce a stronger strand. Catgut treated in this way lasts in the tissues about as long as the same sized strand treated by most of the other methods in vogue at the present time, the No. 2 gut generally requiring about one week for its absorption. I have not found that the material so treated deteriorates at all with age, neither as far as strength or sterility is concerned. In fact, I have recently had a large number of strands bacteriologically examined from a jar which had been frequently opened during the past year, and have yet to find the first one infected or in any other way undesirable for use in surgery."

All material that can be boiled for one hour is perfectly safe to use for sutures which are to be removed because such boiling insures the sterility of the material at the time it is placed in the wound, provided it is not infected during its introduction. Of course, it may be infected while passing through the skin or from micro-organisms which progress along the suture between the time of its insertion and the time of its removal, or from micro-organisms existing in the blood which may become located at this point of traumatism, but if the stitches are not tied too tightly this result is not likely to occur, because there will not be a favorable culture medium along the stitch unless prepared by pressure necrosis.

TANNED CATGUT

Ssobolew method. The catgut is wound loosely upon glass slides. It is immersed for twenty-four hours in extract of quebracho to which one per

cent. of phenol has been added. It is then washed in sterile water and immersed for twenty-four hours in an aqueous solution of formaldehyde actually 4 per cent. but 10 per cent. of commercial formalin in water. It is then washed for twenty-four hours in running water, then boiled for fifteen minutes in water and while still hot it is immersed in a mixture of 96 per cent. strong commercial alcohol 91 parts, glycerine 5 parts and phenol 4 parts. In this solution it may be preserved indefinitely, being washed in water to remove the phenol before using.

It may also be placed in this mixture for a time and then preserved indefinitely in the iodoform-ether-alcohol mixture previously described.

The finest catgut will absorb in not less than two weeks, and the larger sizes in from two to six weeks.

Ligature material boiled in paraffine. Of the boilable materials for suturing silk, linen, either plain or covered with celluloid, also these materials boiled in paraffine at a temperature not to exceed 150 degrees C. or in 10 per cent. of iodoform in paraffine, may be employed with perfect safety provided the sutures extend through the surface so that they may be removed or that only the very fine threads are used in case of buried sutures or ligatures.

Hyper-tension favors suppuration. Many surgeons complain of suppuration when using catgut for ligatures and buried sutures who are much more fortunate when they use for these purposes only the finest silk or linen. We are convinced of the fact that this is due to the circumstance that when using catgut an amount of tension is applied in tying the sutures or ligatures which would break the fine silk or linen, and consequently when using the latter material these surgeons cannot cause the same amount of pressure necrosis as they can when using the much heavier catgut.

DISINFECTION OF DRESSINGS

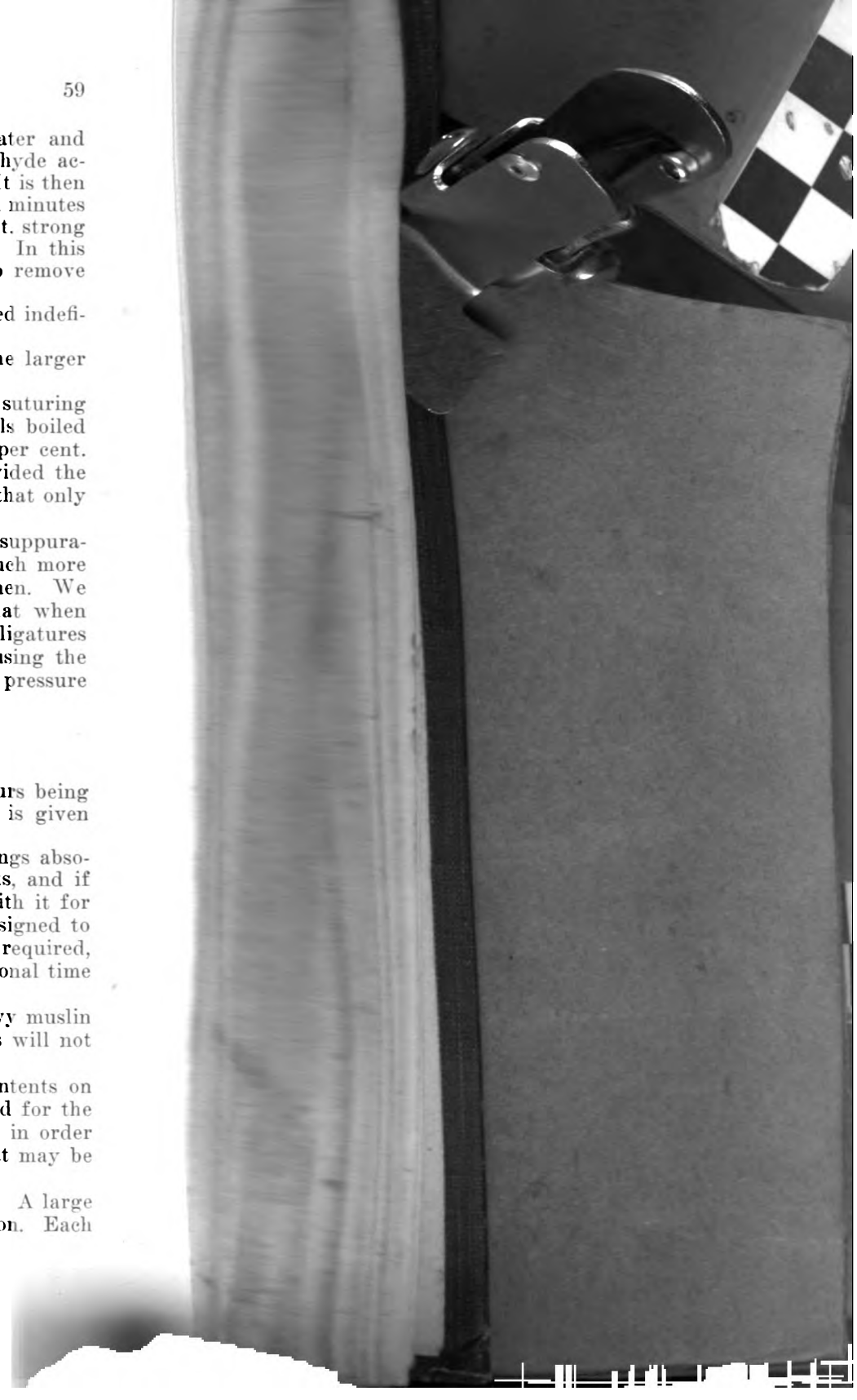
All dressings should be disinfected in a steam sterilizer, two hours being given for steaming and one hour for drying. The same treatment is given to aprons, sheets and towels.

One-fourth of this time is quite sufficient to make surgical dressings absolutely sterile, as has been demonstrated by hundreds of experiments, and if this work is in the personal care of one who has been entrusted with it for a long period the time may be reduced accordingly, but if it is assigned to the nurses in general, it is better to allow more time than is actually required, as no harm is done to the dressing material by exposing it the additional time to the superheated steam in the sterilizer.

The dressings should be arranged in packages and placed in heavy muslin bags or folded in thick towels securely pinned so that the contents will not be contaminated when these packages are handled.

Each package should be labeled by writing the name of the contents on the covering with lead pencil, or if permanent bags are always used for the same contents these may be permanently labeled with indelible ink in order that it may never be necessary to examine the contents to find what may be wanted.

All abdominal pads should be cut in three or four lengths only. A large number of sizes usually complicates the counting during the operation. Each size should have a definite, uniform length.



We have found that the most satisfactory method of preventing the loss of pads in the abdomen is that of counting. All such pads are placed in packages containing one dozen. The pads which have been used during the operation are collected by a nurse who is responsible for this duty, and she places them in lots of one dozen each. At the end of the operation, the pads she has left, plus those on the operating table, plus those still in possession of the surgical nurse, should total twelve, or a multiple of twelve. In this way the count is constantly kept up.

It is also well to have all of the pads cut by measure by one individual nurse for a number of months. No one, except the surgeon and the nurse at the head of the surgical department, should know the exact length of each type of pads, of which a record should be kept giving the period during which these sizes were in use. In at least one instance in a malpractice suit, in which it was claimed that a strip of gauze twenty-five feet long was found in the patient several months after operation, the fact that no pads had been used at that time which were longer than nine feet, proved that the pad which was claimed to have been found, had been fraudulently inserted by some one who had planned to extort money from the surgeon.

DISINFECTION OF EVERYTHING COMING DIRECTLY IN CONTACT WITH WOUNDS

The basins, instrument pans, jars for dressings, etc., are to be boiled in soda and water for one hour, then wrapped up in sterilized sheets until used. The tables should be scrubbed with soap and water and then with 1 to 1,000 corrosive sublimate in water, and have them always covered with a double sterilized sheet when in use. The ordinary pads of cotton and of gauze, sterilized in a steam sterilizer, are used in place of sponges in all operations.

A one per cent. solution of formaldehyde in water is very satisfactory for washing all of these apparati and especially for the purpose of disinfecting bath-tubs and stationary wash-basins. The latter should, however, never be used in operating rooms where all the basins for washing the hands of the surgeon, assistants and nurses are so arranged that they can be removed from the stands and boiled, a sufficient number of these removable basins being kept ready so that they may be replaced by sterile ones between operations.

The nurses who scrub these various utensils with these strong antiseptic solutions should invariably wear thick rubber gloves while performing this portion of their duties, because the skin of their hands will otherwise become roughened and thus constitute a danger to the service owing to the ease with which infectious material may become lodged in the crevices formed.

DRAINAGE

When used. Drainage is always used in very large, clean wounds, such as breast amputations with removal of the pectoralis major and minor muscles and axillary glands, also in thigh amputations, usually only for three or four days; never in herniotomies except for strangulated hernia complicated with gangrene, nor in small, clean wounds.

Rubber tubing. The ordinary perforated rubber tube is employed. It is always used in wounds that are primarily septic; and whenever there is any doubt as to the aseptic condition of a wound we drain. We have found the

use of an ordinary leather punch very convenient for making the necessary perforations in rubber tubing. In many instances, rubber tubes split longitudinally throughout seem to be especially useful.

Glass tubes. In wounds in which the pressure from the dressing would be likely to cause collapse of a rubber drainage tube, as, for instance, in operations for the removal of goitre, the small perforated glass tubes introduced by Kocher are most satisfactory. They may be kept on hand in various forms both straight and curved, and in various lengths and sizes, in order that they may suit the conditions found in any given case.

In the abdominal cavity we use glass tubes, closed at the end, having a number of small perforations toward the lower end. A strand of gauze is carried to the bottom of the tube to act as a capillary drain. A piece of iodoform or formidin gauze, folded about four double, is placed over the glass tube, which is then, with this covering, carried down to the point to be drained. In operations upon the pelvic organs it is carried to the bottom of the cul-de-sac of Douglas.

Glass and rubber drainage tubes are usually removed in from two to five days after an operation. In this length of time drainage will have been established and danger of pressure-necrosis is avoided.

CIGARETTE DRAIN

In order to prevent the formation of adhesions between portions of the intestines which come in contact with the gauze covering the glass drain the latter is surrounded on the side directed toward the intestines or stomach by a row of so-called cigarette drains, introduced by Robert Morris. These drains are made by placing one or more layers of gauze upon a piece of gutta percha tissue so that the former is two or three cm. longer and five or more cm. narrower than the latter. The gauze is then rolled up inside of the tissue so that it will be entirely covered by the latter and so that its ends will project slightly from either extremity, giving the drain the appearance of a cigarette varying in size according to the area to be drained. Thus a capillary drain is constructed which is surrounded by a non-irritating, soft, pliable covering of gutta percha tissue.

A similar drain can be made by splitting a large soft rubber drainage tube longitudinally and placing a strand of gauze within its lumen.

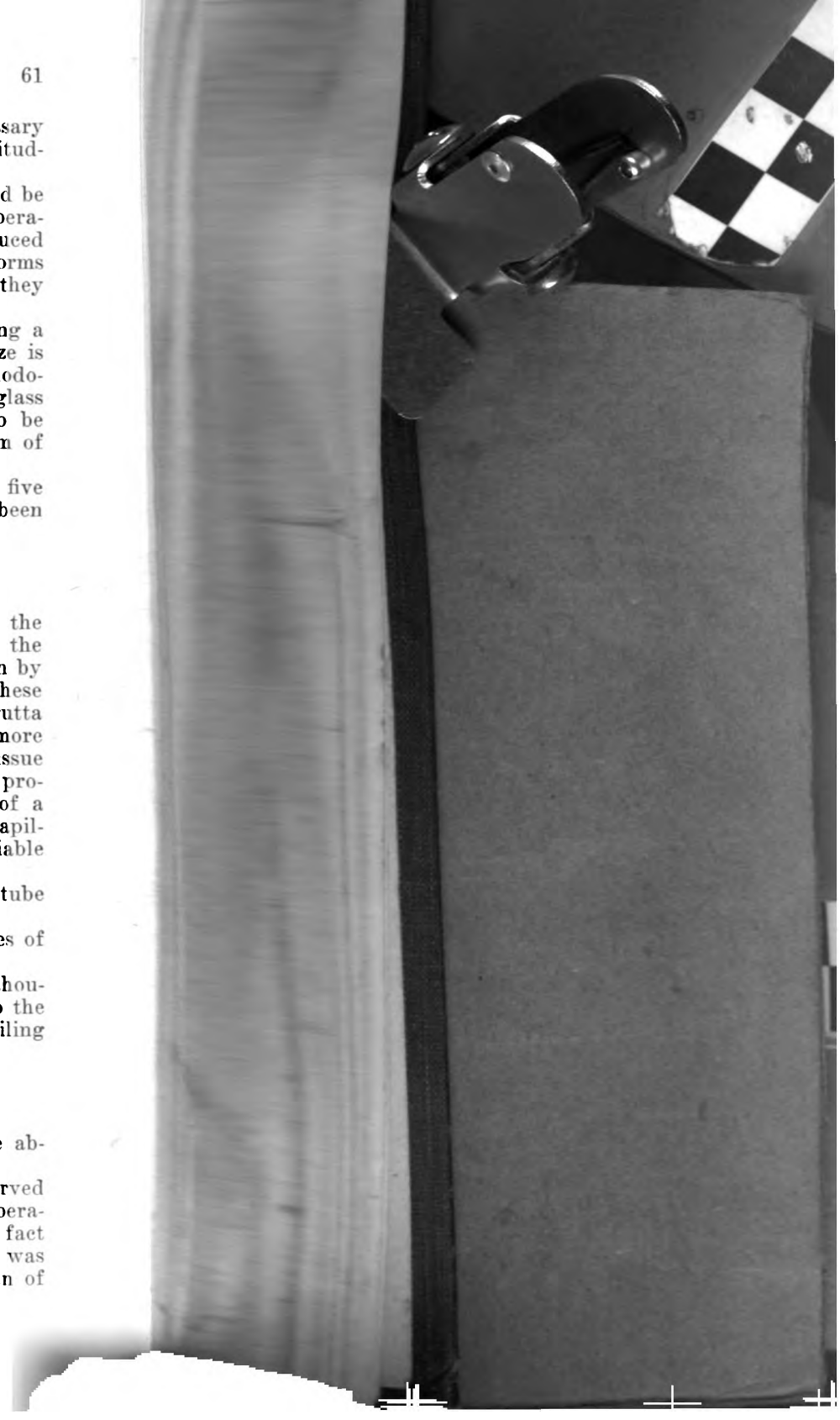
In order to prevent adhesions and also to facilitate drainage, flat tapes of sterile gauze saturated with vaseline oil may be used.

The gutta percha tissue may be disinfected by washing in one to one thousand of corrosive sublimate in water and by exposing the moist sheets to the fumes of formaldehyde. The material will not bear disinfection by boiling or by exposure to steam.

IRRIGATION

We practically never use irrigation during operations, either in the abdominal cavity or elsewhere.

[During the early days of my surgical work, as an assistant, I observed that wounds in abdominal sections healed more smoothly than in other operations, and the only real difference in the treatment observable was the fact that no irrigation was used in connection with the former, while it was invariably employed in the others. I consequently applied the same plan of



treatment to all wounds as early as 1889, and have since constantly operated dry in clean cases, and, since a number of years, also in cases containing pus. I have treated wounds in circumscribed tuberculous lesions by applying strong compound tincture of iodine, and then sponging the area with moist gauze sponges before tamponing with iodoform gauze or before closing with sutures. These wounds have progressed well, but I do not feel convinced that the iodine has been responsible for this fact. Very recently in tuberculosis of the joints I have applied strong carbolic acid to the surfaces of the bones for two minutes, and have then washed these parts thoroughly with strong alcohol until all of the carbolic acid seemed removed. I am convinced that irrigation is rarely of any real benefit and that it is frequently harmful in carrying infectious material to portions which might otherwise have escaped infection. —Ochsner.]

Primary union depends upon thorough system. Our observations have convinced us that it is an exceedingly simple matter to obtain primary union almost invariably if one has a reasonable system, i. e., a system which keeps the attention of operator, assistants and nurses constantly on guard to prevent accidental contamination.

Whenever some new method is on trial in any hospital or clinic every one is interested and, consequently, accidental contamination is not likely to occur. It is for this reason that the various new methods are so successful in the hands of their originators.

Theory vs. practice in surgical methods. A close observation of antiseptic and aseptic surgery from its beginning to the present time has led us to the conclusion that there is a vast amount of difference and contradiction between the theories, which are at present generally accepted, and the practical results. So far as a scientific study of the subject is concerned, both the theoretical considerations, which are mainly based upon scientific experiments, and the practical observations upon wounds, must be borne in mind. So far as the welfare of any particular patient, or any group of patients, is concerned, only those facts which practice has shown to be of importance in order to secure primary union should be considered, because they will bear directly upon the welfare of a human being who has entrusted himself to our care. The following conclusions will serve to express our position upon this subject.

1. (a) Theoretically it is almost impossible to absolutely disinfect the skin of the patient and the hands of the operator.

(b) Practically it is one of the easiest and simplest tasks to obtain a degree of surgical cleanliness that will insure primary wound-healing.

2. (a) Theoretically, strong chemical disinfectants are indicated for the purpose of disinfecting the hands.

(b) Practically, careful washing with the mildest, viz., soap and water and alcohol, is absolutely sufficient and very much safer for the patient, because hands roughened by the use of strong antiseptics are much more prone to become hopelessly septic than hands which are covered with smooth, healthy skin.

3. (a) Theoretically, it is extremely simple to keep the hands aseptic after they have been rendered so.

(b) Practically, there is no more difficult task in any clinic, or during an operation in a private house, than to keep all interested hands clean after they have been disinfected.

4. (a) Theoretically, sutures passing through the skin and the deep tissues underneath are a menace to the patient, because they form a direct commu-

nication between the skin, containing staphylococci, and the deep tissues which are primarily sterile.

(b) Practically, these stitches never cause an infection, unless drawn too tightly, in which case the resulting pressure-necrosis is the cause of the mischief as it furnishes these micro-organisms dead tissue to thrive upon.

5. (a) Theoretically, catgut sutures and ligatures are objectionable.

(b) Practically, if applied properly by a clean surgeon with clean assistants, and not tied too tightly, they are absolutely satisfactory and not objectionable.

6. (a) Theoretically, it is as safe to operate upon clean cases after dressing suppurating wounds as at any other time.

(b) Practically, surgeons who follow this practice always have a great amount of wound infection, on account of accidental contamination of something coming in contact with the wounds.

Conditions requisite to asepsis. In order to have wounds heal without suppuration we believe the following conditions should be enforced:

1. The surgeon, his assistants and nurses, must be habitually clean, and the skin of their hands must be free from irritation and roughness.

2. Their attention should constantly be directed toward the prevention of accidental infection.

3. The surgeon and his assistants should be careful not to breathe or speak into the wounds.

4. Tissues should not be exposed to unnecessary traumatism.

5. Sutures should not be tied tightly enough to cause pressure-necrosis.

6. A reasonable system should be employed so that every one concerned can assist intelligently in preventing infection.

THE OPERATING ROOM

Direction of light. The hospitals of this country are all supplied with suitable operating rooms, with the one criticism that many of them are badly-lighted. The light should come from the north and from sky-lights facing north, in order to have uniform brightness and not direct sun-light, and to avoid the overwhelming heat which is caused by sky-lights facing the sun.

In great cities operating-rooms should be on the highest floor in high buildings, because the air contains much less street dust in the upper stories of a high building than near the ground, and consequently less infectious material is likely to accumulate in places from which an infection can be carried to the wounds.

Advantages of the hospital. Operations are always best performed in hospitals, and every city and town in the country should support a hospital suitable in size to the community tributary to it. This can be established and maintained at a small cost and is of great benefit to the community because it supplies a means of proper treatment for cases which must otherwise be satisfied with generally very inefficient care. Moreover, it serves as the most powerful incentive for the entire medical profession in the community in which it is maintained because it furnishes a reasonable opportunity for advancement.

The leading consideration in the private home. But a few operations must at present be performed in the homes of patients and here it might be considered more difficult to arrange an operating room. As a matter of fact there is but one point to be borne in mind in the arrangement of a room for

operating, namely, infection, and that no wound infection is to be considered except from contact. Not that infection from the air is absolutely impossible theoretically, but that, practically, a wound remains aseptic unless infectious material has been placed in it by dirty hands, dirty instruments, appliances or sponges, ligatures, sutures or dressings, unless the infectious material existed in the patient's body at the time of operation. Of course the operator could infect a wound by breathing or speaking into it if his pharynx or air passages were infected.

Universal cleanliness required. But in any case in which a clean surgeon with clean assistants and clean appliances operates upon a clean patient, it can be expected with a fair degree of certainty that the wound will remain aseptic, no matter what the surroundings may be. On the other hand, the most perfectly appointed operating-room cannot prevent a septic surgeon from having his wounds in clean patients suppurate.

Details of preparation in the private home. It is best, when compelled to operate in a dwelling-house, to choose the lightest room, to make as little disturbance as possible, and thus avoid stirring up dust, to arrange everything very simply and to utilize the least possible amount of furniture. An ordinary extension table will serve admirably for an operating table. Let it be drawn out so that there is a space of three feet in the center and then two of the boards may be placed lengthwise so as to leave a notch on one side for the surgeon to stand and on the other side for his assistant. A quilt or blanket may be folded upon itself three or four times and placed lengthwise upon the table and this covered with a freshly-laundered sheet. A small stand or table is placed at the side of the operator and covered with a sterile towel, and on this are placed the instruments, ligatures, sutures and sterilized dressings. Upon chairs or a bench, or another table, two or three basins are placed containing boiled water. Into one of these a sufficient number of tablets of corrosive sublimate are thrown to make a solution of 1 to 2,000.

After preparing the surface to be operated, and the surgeon's hands, as described in a previous section, the operation may proceed, but every one connected with the work must bear in mind throughout the operation that nothing is to be touched by any one except those things that have been sterilized. If anything has been touched by accident or intentionally, the hands of such person or persons must again be disinfected.

It is not at all uncommon after making the most careful preparations for an asceptic operation to have some one who comes in contact with the wound, directly or indirectly, thoughtlessly produce an infection by handling some object which is not sterile. If it is necessary to depend upon unskilled assistants, it is well to cover their hands with sterilized rubber gloves and to virtually perform the operation alone. It is well to carry a good supply of sterilized towels and dressings in order to be able to cover everything in the vicinity of the operation.

Instruments may be carried sterile in a canvas roll and covered with a sterile towel, and the ligatures and suture material may be carried in bottles. Basins may be placed in a wash boiler and sterilized by boiling while the preparations are being made for the operation.

Sterilized gauze may be cut in suitable lengths to serve as sponges.

From this it will be seen that it is not very difficult to prepare an operating room in an ordinary dwelling-house, but no operator ever does his best work anywhere except in his own regular operating-room.

Simplicity of detail to be studied. Whether the operation be performed

in a well-appointed operating-room or in a dwelling house, much will be gained for the patient if the surgeon appreciates the great value of simplicity. If only that is done which is actually of value to the patient, much will be gained for him, because it is through unnecessary manipulations that one is especially likely to carry infection to the wound.

GENERAL ANESTHESIA

Ether and chloroform are the only two general anesthetics which seem to have stood the test of time; not that they are entirely safe, nor that they are entirely satisfactory, but rather that they are less unsatisfactory than the other substances which have come into use and been discarded again. With chloroform there is a considerable amount of danger at the time of its administration, and in the use of ether there is some danger from pneumonia following recovery from the anesthesia because of the great irritation of the respiratory tract.

The various contra-indications will be considered in connection with the clinical cases wherein they are found. For the present only points of general application will be considered.

General influences. The careful general examination which was described in the first sections will have determined any pathological conditions of the heart, the kidneys and the lungs, the three organs especially to be studied by the anesthetist. If one or more of these organs have been found to be pathological it will be wise for the anesthetist to be even more cautious than he would otherwise, if this is possible, and for the surgeon to limit his operation to the very shortest consistent time. The induction of anesthesia should be somewhat slower and the anesthesia just sufficiently profound to permit the operation without disturbance or interruption by the patient.

Organic heart lesions not positively forbidding. Singularly, in our experience patients suffering from organic heart lesions have never exhibited any serious or alarming difficulty during the administration of an anesthetic, while patients whose heart, lungs and kidneys were normal at the time of taking anesthetics have sometimes shown serious symptoms.

In a symposium on this subject before the College of Physicians of Philadelphia in which many of the most experienced surgeons of this country participated, no one had seen a death from anesthesia in any case in which there had been a demonstrable heart lesion.

No one would reason from this that the former class of patients are better subjects for the administration of anesthetics, but rather that the presence of their unfavorable condition caused the anesthetists to exercise unusual care in all of them.

From this it would seem that it is perfectly safe to give anesthetics in cases suffering from valvular heart lesions, provided this is known at the time the anesthetic is administered. We believe that it also shows that if the same care which has been employed in these cases were regularly taken in all cases, the present low mortality from anesthesia would be still further reduced.

Chloroform followed by ether. The method of administering chloroform, followed by ether, which has been satisfactory in our own practice, although now superseded by ether alone, consists in first quieting the fears of the patient, then applying across the patient's eyes a piece of rubber ten cm. wide and fifteen cm. long and over this a pad of sterilized gauze, six or eight thicknesses, and about three inches wide and eight inches long, held in place by a towel

which is pinned around the head so that its lower margin crosses the nose below its middle to protect the eyes against irritation from the anesthetic, and incidentally to soothe the patient by having the eyes closed. An ordinary Esmarch chloroform mask covered with two thicknesses of stockinette is then placed over the mouth and nose and chloroform is dropped upon this very slowly but continuously, care being taken to constantly change the point upon which the drops fall so as to apply the chloroform to different parts of the mask with uniformity. Then the patient is told to count aloud slowly after the anesthetist, who speaks numbers of three figures slowly, then waits for the patient to repeat the same number, then he calls the next higher or lower number. This is continued until the patient is asleep. By choosing a large number to be repeated by the patient the latter exhales freely while counting and later inhales quite as freely while the anesthetist repeats the next number. His attention being directed toward the unusual feature prevents him from causing any voluntary irregularity in his respiration. This causes him to breathe deeply and at the same time to divert his attention from the anesthesia.

So long as the patient counts with loud voice, after the anesthetist, his breathing is fairly regular and there is little danger in the administration of chloroform, provided the gauze covering the mask is not too thick to permit a sufficient amount of air to enter with the chloroform (for this reason only two thicknesses of ordinary gauze or stockinette should be used).

After the patient has been thoroughly anesthetized with chloroform, and for at least one minute before the operation is begun, ether is administered with the same mask, also by the drop method, with the difference, however, that the gauze is kept thoroughly saturated with ether and that four layers of gauze, or two layers of stockinette, are placed on the Esmarch mask.

Safety of the method. When a surgeon is compelled to operate without a skilled anesthetist, which is a very common experience for the practitioner in the country, the administration of the ether can safely be placed in the hands of any one, provided this method be employed. The surgeon can prepare everything for the operation, he can then give the chloroform himself until the patient is asleep, then after giving ether for a minute or more this may be placed in the hands of any intelligent person and the surgeon can again disinfect his hands and proceed to perform the operation. Even in hospitals where there are skilled anesthetists this method is satisfactory.

If for any reason the patient does not take ether well he will frequently take chloroform without disturbance, and it is usually well to change the anesthetic in any case in which there seems to be difficulty with giving one or the other or these two. We have, however, adopted the rule never to return to the use of chloroform in any given case in which this anesthetic is not well taken, fearing that it might result in a serious or even fatal accident.

If the patient does not take ether well it may be disagreeable to continue its use, but it is nevertheless ordinarily safe.

Danger signals. There is no sign of danger in the administration of anesthetics upon which one can depend absolutely, but there are a number of signs which should always have immediate and careful attention when they appear. In most cases of danger respiration is at first impaired; in some the respiration and the circulation suffer at the same time, while in others the heart stops beating suddenly before the respiration ceases.

In case the blood in the wound is dark or the patient's face or ears become cyanotic the administration of the anesthetic should be immediately interrupted.

As soon as danger signs appear, however, the ether and mask should be removed at once, and it is usually not well to apply the anesthetic a second time. The patient who may cry out from pain in the later stages of an operation is better off than if exposed to the risk of further anesthesia if he has shown signs of being in danger of serious trouble during the operation.

Means of relief. In time of trouble we have found greater benefit and prompter relief by first pressing forcibly upon the chest several times, in order to force out from the lungs, as much as possible, the air laden with chloroform, and then by means of artificial respiration supplying pure air in its place.

If no air seems to enter the lungs upon attempting artificial respiration it is well to rapidly place a gag between the teeth and with the finger to raise up the epiglottis away from the larynx; this can sometimes be accomplished very quickly by pulling the tongue forward rapidly with a pair of tongue forceps.

The operator can frequently recognize impending danger to the patient from the anesthetic by the lack of bleeding from the wound and by the dark color of the blood, indicating insufficient aëration.

Above all things, the anesthetist should give his entire attention to his work and should never crowd the anesthetic in order to hasten the anesthesia.

Preference given to ether. For several years we have abandoned the use of chloroform anesthesia completely because it has been found that using the drop method of administering ether, which was first introduced in the Augustana Hospital by L. H. Prince over twenty-five years ago, anesthesia can be accomplished almost without either immediate or remote danger. The amount of ether given is thus exceedingly small, and the patient is completely under its influence, in from two to ten minutes. In cases in which two ounces of castor oil have been given on the day before the operation, nausea and vomiting rarely occurs. The patient recovers from the anesthetic very rapidly and without pulmonary irritation.

The mask invented by Ferguson, which is constructed of malleable copper wire so that it can be accurately fitted to the patient's face, is most useful; the amount of ether given can be most accurately regulated and much waste is therefore prevented.

Morphin and atropin hypodermically. In patients with irritable bronchial mucous membranes it is well to administer one-fourth grain of morphin and one one-hundredth grain of atropin hypodermically half an hour before beginning the anesthetic. This will prevent the accumulation of frothy mucus during the administration of the anesthetic, which is especially desirable in operations about the head or neck. This also reduces the amount of ether required for accomplishing satisfactory anesthesia.

It is to be remembered, however, that whatever anesthetic and whatever method of administration may be chosen it is always of great importance to the patient to reduce the time limit to a minimum.

NITROUS OXIDE GAS ANESTHESIA

During the past few years many surgeons have used nitrous oxide gas anesthesia for operations lasting up to, and even beyond, one hour. This gas has been used safely in an enormous number of dental operations, and in other short-term operations for many years with great satisfaction.

No advantage as an introductory agent. Of late it has been used for gen-

eral operative work in many cases for the purpose of anesthetizing the patient primarily to avoid the annoyance of taking ether, and later continuing the anesthesia with ether or chloroform. In order to determine the value of this method we employed it in one hundred successive cases and compared the anesthesia, the patient's sensations and the condition of the patient after the operation with cases operated before and after this test period under ether anesthesia applied by the drop method. We found no difference in the course of the anesthesia, nor in the comfort of the patient, but there was a little more bronchial irritation following operation when nitrous oxide gas had been used. The method was more cumbersome and consequently it was permanently abandoned. For a time it was necessary to give patients the choice of this anesthetic because they had obtained the idea elsewhere that it was much safer and so some were slightly prejudiced in favor of the method, but aside from the slight advertising value, which the method undoubtedly possesses, we are convinced that it has no especial value as compared with ether properly administered by the drop plan.

The same value is present, possibly to a somewhat greater degree, in the method now more frequently employed of a combination of nitrous oxide gas and oxygen. Here the patient is successively asphyxiated by the use of nitrous oxide gas and resuscitated by the oxygen gas. A skilled anesthetist can accomplish these two processes so cleverly that any operation not affected by muscular rigidity can be performed under this anesthesia.

This form of anesthesia not good in intra-abdominal work. In intra-abdominal operations we have found the additional traumatism necessitated by the rigidity of the abdominal muscles causes a great increase in the pain suffered by the patient after operation. This can, however, be overcome by giving from one-sixth to one-third of a grain of morphia with one one-hundredth of a grain of atropin half an hour before the operation is commenced, and by giving morphia after operation in case of pain. The method undoubtedly exposes the patient to conditions which cannot be considered harmless. Were a patient exposed to the same degree of asphyxia, for the same period of time, from any other cause, it seems reasonable to suppose that any physician would look upon this as a severe strain upon the physiological processes. After the newness of this method has worn off, these secondary considerations will undoubtedly receive more careful attention.

Other contraindications. It seems wise never to follow this course of anesthesia in any operation lasting longer than a few minutes, unless a well-trained anesthetist is available, and then never in plethoric patients nor in cases suffering from cardiac dilatation, myocarditis, valvular heart lesions, nor in those suffering from obstruction to respiration from any cause. Patients with arterio-sclerosis or with high blood pressure are also bad subjects for the use of this form of anesthesia.

The use of nitrous oxide anesthesia is especially contraindicated in conditions such as severe anemia, lowered or much increased blood pressure, diabetes, advanced nephritis, status lymphaticus, morbus Basedowi, Addison's disease, myocarditis, advanced cardiac and pulmonary disease. In these cases the use of local anesthesia should be considered.

In cases in which this form of anesthesia seems safe, it is not needed because they do equally well with the use of ether by the drop method, and in those in which one dislikes to give ether this method is contraindicated. For some time to come there will be a certain amount of advertising advantage, but as soon as this has been dissipated by the fact that everyone will be pre-

pared to administer this form of anesthesia, its drawbacks must become apparent as compared with its advantages.

Indications. Nitrous oxide anesthesia is satisfactory to use in short minor operations, such as pulling teeth, opening abscesses, etc., but not when complete muscular relaxation is desired. The only real merits are the comfort to the patient in inducing the anesthesia, and the rapidity with which patients regain consciousness.

Ether is the best general anesthesia. Ether anesthesia when applied properly by the drop method is no less comfortable, and if interrupted when the surgeon begins to apply the sutures the patient will awaken almost immediately after the conclusion of the operation, but will then usually again fall asleep and so remain naturally for several hours, while after nitrous oxide anesthesia he is likely to be kept awake by the pain in the wound unless morphia is administered. Bronchial irritation is not more common after ether anesthesia, if carried out as described heretofore, than after nitrous oxide anesthesia. If the plan of administering two ounces of castor oil twenty-four hours before the operation is strictly adhered to, there is almost no vomiting, no matter what anesthetic may be employed.

LOCAL ANESTHESIA OR ANALGESIA

The use of substances injected into the tissues to produce anesthesia in a local area has become popularized to a marked degree during the past few years. In fact, some surgeons are using this method in a large proportion of their routine cases.

There should be no doubt as to the extent of the operation, because the anesthetic being limited to a local area, dragging of the tissue may affect other organs beyond the area of anesthesia. In some instances the administration of a local anesthetic may be more painful than the operation itself, and this would, of course, bar its use. All anesthetics have their disadvantages and dangers.

Consciousness a disadvantage. Consciousness during the operation is a great disadvantage to the operator unless he has the confidence of the patient. It is almost impracticable with many nervous individuals and children. In such the shock of apprehension may be greater than that which may result from the use of a general anesthetic.

Methods of action. Local anesthetics act in one of three ways, viz.: 1st, By producing an anemia of the capillaries supplying the nerve-endings. 2d, By direct action on the nerve-endings. 3d, By direct action on the nerve-fibres.

When about to perform an operation under local anesthesia all preparations should be completed before the patient is brought into the room. During the operation the patient's face should be covered, unnecessary conversation should be avoided and comparative silence should prevail. Stimulants should be at hand, and the patient should be carefully watched.

The chief object of this method is to produce anesthesia over a limited area, therefore a constricting band above the field of operation or the use of adrenalin are advisable, for, not only do they limit the field of action but they also diminish the amount of anesthetic required and the hemorrhage following.

Most common drugs. The drugs most commonly used for the purpose of producing local anesthesia are cocaine, beta-eucaine, novocain, tropacocain and ethyl-chloride. We have been in the habit of using cocaine for a number of years and to entire satisfaction. Also a ½ per cent. solution of novocain, has been most satisfactory in our practice.

Cocaine. Cocaine when applied to the unbroken skin produces no effect. When applied to the mucous membrane or when injected beneath the skin it causes a tingling sensation, followed by a paralysis of sensation due to its toxic effect upon the nerve endings. It also produces anemia from constriction of the capillaries, followed by hyperemia from secondary dilatation. The local action of cocaine is very brief, after which it is rapidly absorbed, and may produce constitutional symptoms.

At first the use of cocaine was limited to small areas, later the application of the constriction band above the field allowed more surface to be used so that more extensive operations could be performed. With the discovery of adrenalin, Braun suggested its use in combination with cocaine. The danger of the former method was that it only delayed constitutional symptoms. Adrenalin being a hemostatic diminishes hemorrhage, retards absorption and limits the action of the cocaine to a given area, consequently a less amount is necessary and the anesthesia is prolonged from one to three hours.

Preparation of solution. An air-tight metal or glass syringe is very essential. The needle is inserted just beneath and almost parallel with the epidermis in the direction of the line of incision. The solution is then slowly injected until an anemic area is produced into which the needle is gradually advanced, more solution being injected continuously. When the needle will not advance any further, it is withdrawn and the process then repeated. By injecting just beneath the epidermis the cocaine comes in direct contact with the nerve endings and there is very little absorption.

During the past few years we have used in this method, novocaine in ½ per cent. solution, as its toxicity is less than that of cocaine, especially when used with adrenalin solution. At the present time the market contains several preparations such as apothesine, procain, etc., which are identical in their qualities with novocain which we are using in place of the latter with equally satisfactory results.

REGIONAL ANESTHESIA

This method of anesthesia was first introduced by Braun and is of great practical value in certain operations which may be too extensive for the infiltration method and in which a general anesthetic is contra-indicated. This is especially true for operations on the extremities, but in order that it may be carried out successfully an accurate knowledge of the peripheral nerves is essential.

Where the peripheral sensory nerves are superficial, as in the hands and feet, the transverse circular or semi-circular subcutaneous infiltration of a two per cent. cocaine solution will render the skin below insensible to pain. This method is frequently employed for operations on the fingers and toes.

Perineural method. For the performance of operations on the extremities in which deep anesthesia is required, the injection of a two per cent. solution of cocaine and adrenalin about the nerve sheath will paralyze the nerve in from ten to thirty minutes, and anesthesia of the parts to which it is distributed will last from one to three hours. This is known as the perineural method of anesthesia. No harm is done to the nerve and the shock which so frequently follows the section of a large trunk nerve is avoided.

Accessible nerves. The following nerves are accessible for this method:

The supra-orbital branch of the trigeminal just above the supra-orbital notch.

The ulnar behind the internal condyle of the humerus beneath the deep

fascia where it perforates the internal intermuscular septum, also above the wrist beneath the inner side of the flexor carpi ulnaris.

The median just above the annular ligament of the wrist on the inner side of the palmaris longus.

The internal popliteal along the inner border of the biceps tendon behind the head of the fibula.

The occipital major as it passes through the outer border of the trapezius.

The aurico-temporal as it passes backward and outward between the lateral ligaments of the temporo-maxillary joint and the condyle of the jaw close to the temporal artery.

The lingual at the point where the palato-glossal fold and the floor of the mouth meet.

The great auricular, occipital minor and the superficial cervical along the posterior border of the sterno-cleido-mastoid.

The superior laryngeal behind the cornua of the hyoid bone where it passes through the thyro-hyoid membrane.

The dorsal nerve of the penis in the region of the dorsal artery.

Endoneural method. It has been found that by injecting a 1 per cent. cocaine solution with adrenalin directly into the nerve trunk the same results may be obtained as with the perineural method. This is known as the endoneural method. The only advantage is that anesthesia is produced more promptly. The disadvantages are that it can only be used on large nerve trunks. The nerve must first be exposed, and not infrequently a neuritis follows. This method may be used on the crural, the sciatic and the brachial plexus.

Bodine and Cushing have introduced a method of anesthesia for hernia operations. They start the operation with the infiltration method and then inject the ilio-hypogastric and ilio-inguinal nerves as the operation progresses.

SPINAL ANESTHESIA

Spinal anesthesia was first introduced by Bier following the discovery by Corning that cocaine when applied to a nerve trunk produces anesthesia of the region which it supplied.

Dangers and advantages. The mortality following this form of anesthesia is far greater than after ether, and therefore should only be used when the patient can not take the latter and when local or regional anesthesia is impracticable. It has no advantage over ether. The headache, nausea and retching which may follow its use may be more persistent than after ether, so that a spinal puncture may be required to relieve it. Collapse and even sudden death may occur during its application. Focal paralysis and even trophic disturbances may follow its use. With the introduction of newer methods of cocainization, its use is now practically limited to the upper half of the abdomen.

There is no pulmonary irritation. The patient being conscious may be able to aid the operator. There is complete muscular relaxation and no intestinal protrusion.

But it may fail in its purpose. Any accident during the operation alarms the patient and embarrasses the surgeon. In advanced cases of cardiac disease, the shock of apprehension may be worse than that from the operation itself. The operation must be completed within an hour and a half. Pelvic cases are unsafe unless the Trendelenburg posture is dispensed with. Spinal anesthesia cannot be stopped once it is started.

Injury to the spinal cord; hemorrhage into the subdural space; infection of the meninges, and anesthesia of the higher centers are the chief dangers.

The main object in the production of spinal anesthesia is to localize the action of the drug. In order to do this diffusion and gravitation must be overcome. The specific gravity of the spinal fluid is 1.007, therefore, a solution of greater or lesser specific gravity is safer, this depending on the position of the patient. The use of spinal fluid as a vehicle for the cocaine has been adopted with excellent results by Morton in hundreds of cases. To prevent diffusion a viscid substance, such as glucose, has been recommended. This is quite unnecessary, although theoretically it looks attractive. Such a solution forms a stratum so that the action of the cocaine is concentrated at one point and being of greater specific gravity, gravitates to the most dependent part of the spinal canal.

The use of adrenalin retards absorption and prolongs anesthesia, but does not prevent diffusion so that the higher centers of the medulla may become affected.

Points of injection. The region in which the spinal puncture is to be made should be as carefully prepared as for any operation. The patient is placed in the sitting posture with the feet hanging over the side of the bed, or if unable to do this he should be placed on his side with the head elevated. For this procedure a good, graduated syringe with a long needle and stylet are required. The needle is inserted between the third and fourth, or the fifth and sixth lumbar vertebræ between the spines or the laminæ. The former is preferred, there being less danger of injury to the cauda equina, and there is less liability of unilateral anesthesia. A needle with the opening on the side is to be preferred so that as soon as the needle enters the canal, fluid will appear. As soon as the needle enters the sac the stylet is removed and unless fluid appears one is not certain that he is in the spinal canal.

Ethyl chloride. This substance is very volatile and when applied to the skin evaporates rapidly, producing a great amount of cold. As a general anesthetic its use is limited to short operations and except in the hands of an expert it is associated with great danger. Its advantages over ether are the brief period of excitation, the prompt return to consciousness, and the absence of disagreeable after-effects. Locally, it can only be used where a single incision is required and for the introduction of aspirating or transfusion needles. It is sponged upon the surface until the skin is frozen into a hard white mass, then the slight operation is performed before the heat of the body and the temperature of the room have thawed out the frozen skin. The afterpain is rather more severe than in case of general anesthesia, but as the wounds are always small, this is of no great importance.

A ready freezing mixture. The same end can be accomplished by placing equal parts of chipped ice and table-salt in a piece of sterile gauze of about four thicknesses and holding this for about one minute directly upon the area which is to be incised or punctured. This will freeze the skin quite as effectively as the ethyl chloride spray. The gauze may be moistened with a one to 2,000 solution of corrosive sublimate in order to insure antiseptic conditions. This, however, is not necessary, because clean table-salt and clean ice are both sufficiently free from pathogenic micro-organisms to make their use, as described above, safe.

Scopolamin and morphin. We are firmly convinced that the use of scopolamin with morphin for the purpose of anesthesia is to be warned against. It is a very powerful drug combination, different preparations of which vary in

activity. Confusion and violent delirium may follow its administration. We have employed this method sufficiently often to be convinced that it is much more dangerous than ether anesthesia by the drop plan. In cases in which it seems indicated, we greatly prefer to give morphine, one-sixth to one-third grain, with atropin one one-hundred-and-fiftieth to one one-hundredth grain, hypodermically, half an hour before beginning the administration of the anesthetic.

Various modifications of the original plan of using scopolamin and morphine have been suggested and other drugs like hyoscin have been substituted, but the effect is the same. If used in small quantities they seem no more efficient than morphine alone, and when used in large quantities they appear much more dangerous.

ETHYL CHLORIDE

One of the results of the present war has been to bring ethyl chloride into prominence and favor as a general anesthetic. For years ethyl chloride has been employed merely as a local anesthetic, although its property of producing general anesthesia has been known and utilized by a few. Probably because it is so little known and used, ethyl chloride has been considered as unsafe, but those who can speak with authority consider it safe and efficient when administered for transient anesthesia.

Ethyl chloride should be employed as a general anesthetic, first as a preliminary to general ether narcosis, or in cases requiring an anesthesia of short duration, in which a local anesthetic for one reason or another is not adaptable.

Ethyl chloride as a general anesthetic is useful in the following conditions: Incision and drainage of abscesses or furuncles; curettage or cautery of wounds and ulcers; enlarging of wounds for drainage; insertion of drains; removal of drains and packs; renewal of dressings; loose suturing of gaping wounds; operations for ingrown toe-nails; tenotomy; removal of foreign bodies; insertion of pegs and hooks for extension; as a preliminary to ether.

Technique of administration. Preliminary preparation or medication is not necessary, although on general principles it is preferable that the stomach be empty. As in all general anesthetics, loose objects should be removed from the mouth and the respiratory passages should be clear. The patient should lie with the head low and the clothing loosened at the neck. Restraint is not necessary. The eyes are covered and a pad of gauze of eight to ten layers in thickness is placed over the nose and mouth. The patient is instructed to count slowly and ethyl chloride is sprayed, or better rapidly dropped, upon the gauze. Within one-half to two minutes anesthesia is completed, as evidenced by the patient ceasing to count, and by the deep, stertorous respiration. The ethyl chloride may be cautiously continued for two or three minutes before being discontinued. Complete anesthesia persists for two to three minutes from the discontinuance of the administration of the ethyl chloride. Consciousness returns rapidly, often instantly. Following the period of profound anesthesia there is often a short analgesic state. There may be a brief stage of excitement just at the waking moment. With the exception of occasional profuse perspiration, there are no unpleasant after-effects. When the stage of complete anesthesia has been reached it can easily be continued with ether by simply substituting the gauze pad with a mask saturated with ether, and from this point employing the usual drop method. Although anesthesia is profound, there is seldom complete muscular relaxation, and on this account the anesthesia is not satisfactory in the reduction of dislocations and fractures.

GENERAL RULES REGARDING INCISIONS

Rules ignored in malignant growths. In making incisions it is important in the first place to bear in mind the fact that in operating for the removal of malignant growths all rules concerning the direction and extent of incisions may be disregarded if by regarding them there is the slightest danger of leaving any portion of the growth in the body of the patient. In a very large proportion of patients that have come under care in an inoperable and hopeless condition from the recurrence of a malignant growth, some timid surgeon has made the first removal with a view of obtaining a satisfactory cosmetic result. Had the first excision been bold without regard to the necessary deformity, many of these patients would have been permanently relieved by the first operation. For this reason it seems wise to insist at this point on disregarding cosmetic conditions absolutely when they interfere to the slightest degree with thoroughness in dealing with the removal of malignant growths.

In all other cases there are nine conditions to be borne in mind.

Nine rules of guidance. 1. The skin incision should be made in a manner to correspond with the natural folds in order to be as little apparent as possible after healing has taken place. Careful inspection of the surface markings of the skin will always suggest position and direction of the incision, so as to result in the least degree of deformity for the amount of disturbance required by the operation.

2. The underlying anatomical structures must be considered. Of these the important nerves and the large blood vessels are to be heeded; the former because if united after having been once severed, ideal results are not usually obtained; the latter because of the danger of post-operative gangrene or edema in the extremities and of serious cerebral disturbances in case of section of the large vessels in the neck.

3. At points where muscles, aponeuroses or fascia are needed to support important parts, as in the abdominal wall, it is wise to plan all incisions so that the object of the operation may be accomplished and the structures separated so as to secure a fair amount of space for performing the various steps of the operation and still to have muscles and fascia separated or split rather than cut at right angles, in order that when the operation itself has been completed these separations or splittings may be repaired and thus the conditions at the conclusion of the operation, so far as the tissues are concerned through which it was necessary to secure entrance, may be as nearly as possible the same as they were at the beginning of the work.

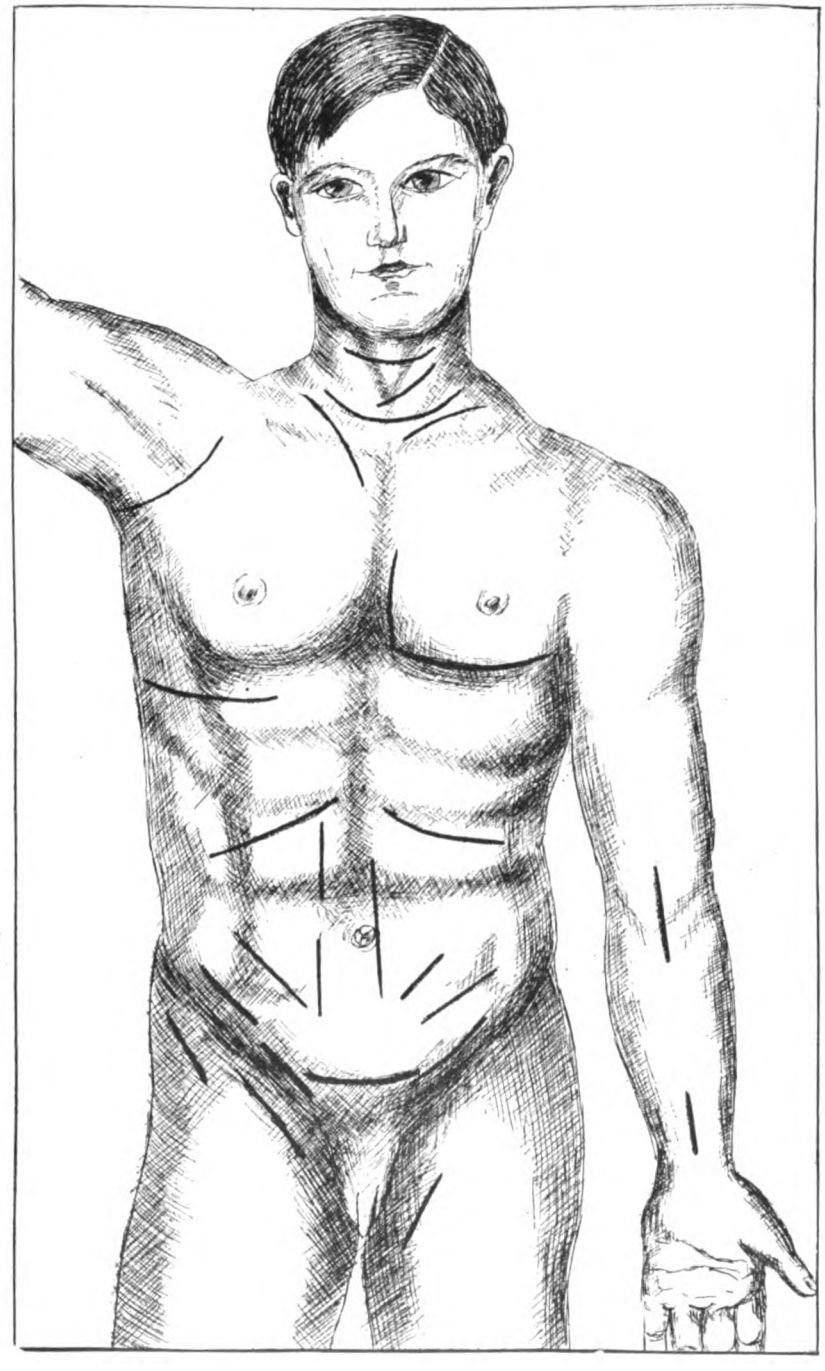
This plan has the further advantage of making it possible to avoid injuring nerves and blood vessels of importance in the region of the operation because these usually lie in the direction of and parallel to the muscles.

4. In portions of the body in which the surface is exposed, as in the neck and face, symmetry should be attained as much as possible. In many instances, as in operations upon the forehead, the nose, the lips, the chin or the neck, a one-sided incision will result in much deformity when an incision extending over both sides resulting in an equal amount of exposure of underlying tissues, will cause but a slight amount of deformity.

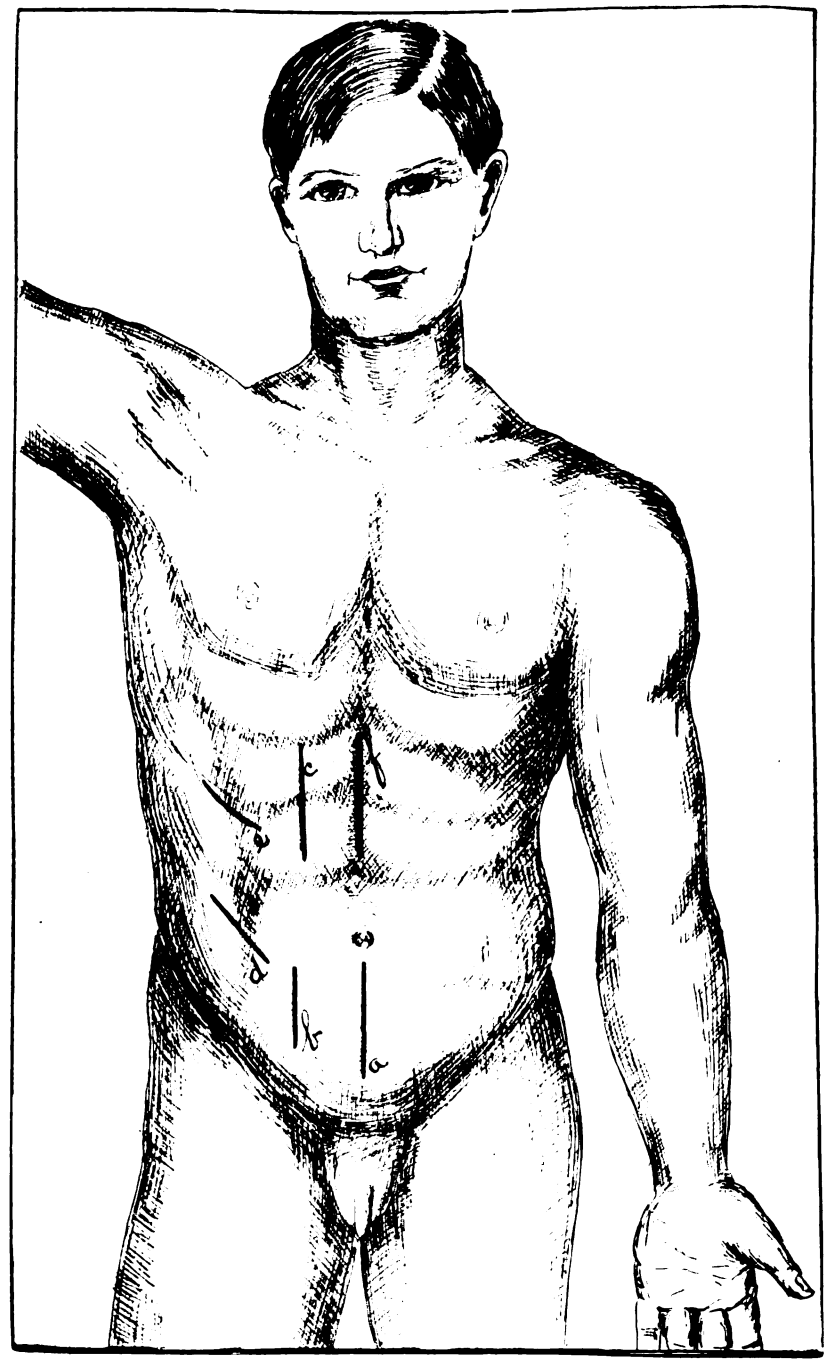
5. It is important to bear in mind the occupation of the patient. Future usefulness may be of so much greater value to the patient in many instances than personal appearance that the latter may be practically disregarded, while in other cases quite the opposite may be the case.

6. It is important to plan incisions so that they will not become painful later, because of pressure or because of the motion of contiguous joints.

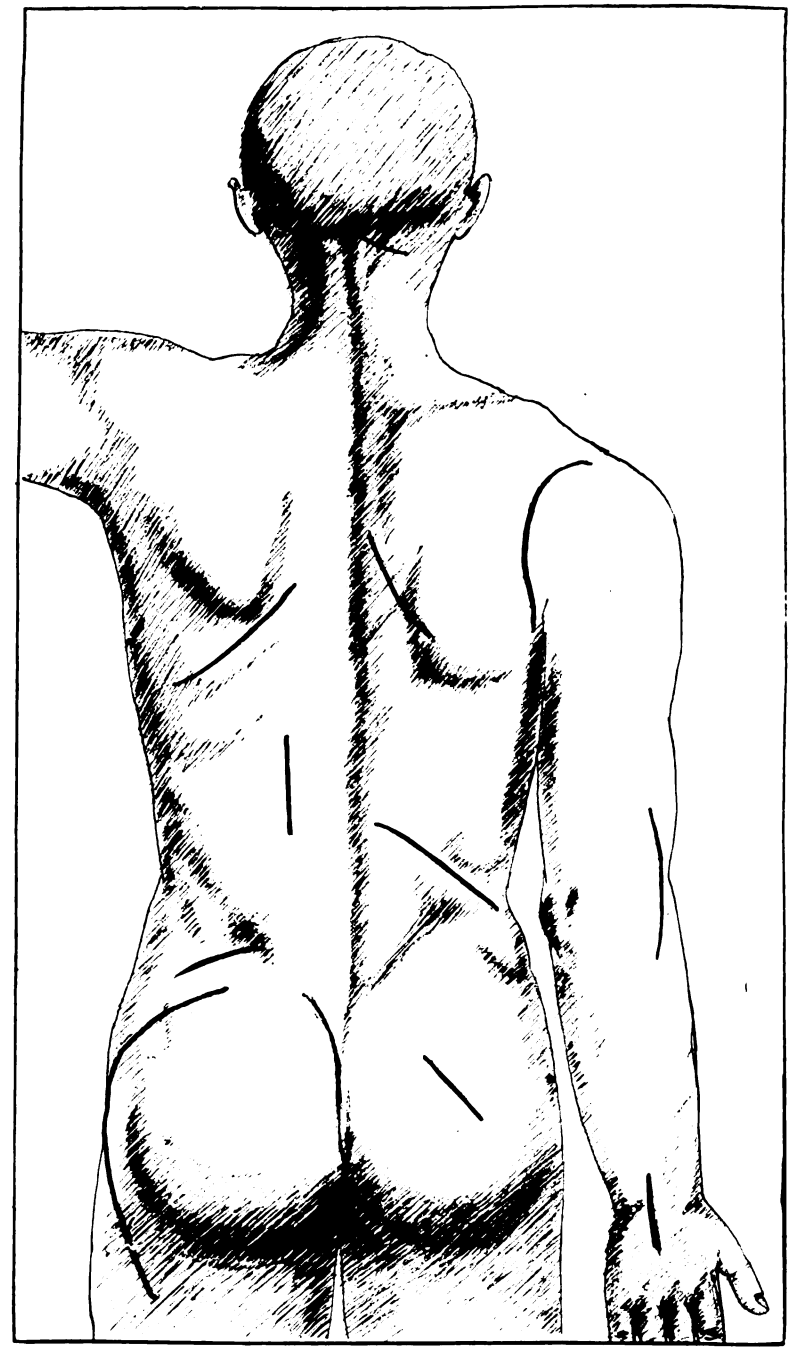
7. Wherever it is possible to hide scars under the natural covering of hair, as in the region of the eyebrows or the male beard, it is well to take advantage of these structures.



ANTERIOR INCISIONAL LINES.



Anterior Abdominal Incisional Lines.



Posterior Incisional Lines.

8. But while considering all of these features, it is important not to lose sight of the fact that the incision must be so planned as to expose the diseased structures to be treated during the surgical operation so that this treatment can be carried out to the best advantage of the patient.

9. In a general way the incision should be made in the direction of the muscles, nerves and blood vessels.

An exceptional rule. There is one exception to this last rule, viz., in exploring for needles or other thin objects that are buried in the tissues and that have been located by the use of skiagrams. It is practically impossible to find these foreign bodies unless the incision is made at right-angles to the object. Of course, if the needle lies parallel to arteries and nerves then the transverse incision will also be at right-angles to these structures, which must be carefuly found and retracted to one end of the incision while the latter penetrates into the depth beyond.

We have repeatedly been able to locate needles buried in the deep tissues in a few moments in cases in which a search of more than an hour had failed to locate the foreign body previously, because this was attempted through an incision parallel or nearly parallel to the foreign body.

The only structures that need to be considered in these instances are the nerves and the blood vessels in case the latter are of any considerable size, and also the tendons. Muscle, fat, skin and fascia may be severed and reunited with catgut sutures.

Surface incisional lines of choice. The choice of location and direction for these incisions has been carefully worked out by many surgeons and anatomists. The scheme developed by Professor Sanger, slightly modified to suit our clinical work, has seemed most simple and still sufficiently comprehensive to be entirely satisfactory.

The accompanying figures represent the lines on the anterior and posterior surfaces of the body.

There is a marked advantage in choosing these lines not only from the fact that one can obtain convenient access to the underlying structures, but also that in these locations one can safely make the incisions sufficiently large to obtain a free view of the tissues to be considered in the operation. It is a mistake to perform operations through incisions which are too small, for fear of producing deformity from making a larger external wound, because if these locations are chosen in a position and direction which is anatomically correct, there is no danger of obtaining ugly scars as the underlying muscles will not distort the resulting cicatrix, and these wounds heal without leaving any considerable deformity. In fact in many instances it is difficult to recognize the scar after a few years.

Separation of deep structures. It is, however, quite as necessary to study the best manner of separating the deeper tissues as it is to choose properly the position and direction of the external wound. Here again it is important, whenever possible, to separate the muscles instead of cutting them. Small arteries and veins may be disregarded. Large blood vessels should be protected, not only against direct injury but also from crushing by the use of retractors, because this undoubtedly often causes phlebitis or thrombosis after surgical operations.

The special details concerning incisions will be fully considered in connection with each individual operation.

HEMOSTASIS

Conserve the blood. It is important to secure prompt and efficient hemostasis during surgical work, because there is a direct relation between the degree of shock and the amount of blood lost by the patient. Whenever it is

possible to isolate blood vessels, to clamp them doubly by applying two pairs of hemostatic forceps, to cut between these and to ligate the proximal end, one has obtained ideal conditions.

In many operations this plan can be carried out to such an extent as to practically prevent loss of blood altogether. Ordinarily, this is of no importance in itself, because most patients can bear the loss of a fair amount of blood without harm; but hemostasis also keeps the tissues clearly exposed so that the anatomical relations can be kept perfectly in view constantly during the operation. This not only facilitates the work, but makes it possible to suture the tissues with all of the structures in their normal relations, leaving the completed operation more perfect than it would be had the field been constantly obscured by being saturated with blood.

Some surgeons have carried this idea to an absurd conclusion. They have insisted upon catching even the smallest vessels with hemostatic forceps and ligating each vessel separately, thus consuming several times as much time as necessary in performing the operation. We have seen a patient kept under an anesthetic for a period of four hours, at least three of such hours being consumed in ligating small vessels which would have ceased bleeding within a few moments without causing any harm to the patient whatever.

On the other hand it is quite as bad to be reckless about the loss of blood, for such disregard is certain to result in the death of a patient occasionally.

It is wise to use strong-jawed hemostatic forceps which will crush the end of the blood vessels of medium and small size. These may be left in place until the operation has been completed when only the large vessels need to be ligated, the crushing having permanently closed the smaller vessels.

It is well to bear in mind that the surface of the wound should not be rubbed with sponges or gauze pads after these forceps have been removed, because this often opens up blood vessels which would otherwise remain closed permanently.

Torsion of blood vessels for hemostasis. Before it was possible always to obtain perfectly sterile, absorbable ligatures the method of grasping blood vessels with hemostatic forceps and twisting them in order to permanently occlude the bleeding point had obtained many adherents. It is reasonable that this should be so. Many surgeons applied this method to vessels as large as the brachial or popliteal artery. Although this can be done safely in most cases, it would be foolish to make use of this method in any of the larger vessels at the present time, because it is not as dependable as ligation, and the latter is quite safe always and has no disadvantages over the former.

Crushing and the application of heat. Several years ago many instruments were invented for the purpose of crushing large blood vessels with an enormous force applied to the jaws of the forceps by means of levers or screw arrangements. These instruments are now temporarily obsolete, but they are certain to be readvised from time to time, although there is no longer any real need because of the fact that ligation with catgut ligatures is more convenient and in every way equally satisfactory and somewhat more reliable even in the hands of surgeons who use the crushing forceps with the greatest care and patience.

Moreover the ligature saves time because the crushing forceps must be left in position at least for a period of one minute in order to make their use fairly safe. For the average surgeon these powerful crushing forceps are not safe because he will not exercise the necessary care in applying them, nor patience to leave in place the necessary length of time. It is quite a different matter from the use of the strong-jawed hemostatic forceps mentioned above, as these can be left attached to the smaller blood vessels while the operation proceeds.

Heated clamps. Dowd has invented a clamp containing a coil of platinum wire for the purpose of heating the jaws of the instrument by passing a current of electricity through the coil.

The clamp is applied to a mass of tissue, like a broad ligament, then its jaws are isolated from the surrounding tissues by a metal shield whose construction makes it a poor conductor of heat, then a current of electricity is passed through the forceps sufficiently strong to heat the blades so that the stump will be thoroughly boiled for twenty to forty seconds. The current is then turned off and the stump is cut beyond the clamps when the latter are removed. In order to prevent the jaws of these clamps from adhering to the cauterized stumps they are thoroughly covered with sterile olive oil before being applied.

The method is perfectly satisfactory, but it seems indicated only in cases in which the portion beyond the pedicle contains malignant tissue, as, for instance, removal of the uterus and ovaries, for the cure of carcinoma of the uterus. In ordinary operations the method is in no way to be preferred to the catgut ligature.

In the removal of organs containing malignant growths the cauterization of the stump may prevent recurrence where there may be invasion extending into but not beyond the stump.

LIGATURE MATERIAL

Catgut ligature the best. Catgut, prepared according to the methods already described, is an ideal ligature material because it has great tensile strength; is absolutely free from septic germs or spores; is thoroughly filled with minute crystals of iodoform which remain in the ligature until the last portion has been absorbed, thus preventing the ligature or the stump of the vessel from becoming a culture medium for micro-organisms which may be present in the circulation. In any location in which it is possible for pressure-necrosis to occur, with subsequent infection due to local conditions, it is wise to use catgut which is so fine that pressure-necrosis is not feared because of the fact that the fine catgut lacks tensile strength enough to crush the tissues sufficiently to cause their death.

In ligating very large vessels it is well to leave a sufficient portion of the vessels projecting beyond the point at which the ligature has been applied so as to prevent slipping. It is also well to crush the wall of the blood vessel at the point at which the ligature is to be applied by the use of strong hemostatic forceps, as this will crush all of the soft tissues and intima out of the blood-vessel wall and leave in place only the connective tissue portion. The same principle applies to the ligation of pedicles of considerable size, such as the pedicle of an ovarian cyst, or the cecal end of the vermiform appendix.

SEARING OF BLEEDING SURFACES

Occasionally there is a constant oozing of blood from the surface of a wound, which does not subside under pressure with hot moist gauze sponges. In these cases it is sometimes well to hold a red or white hot cautery iron near the surface, without actually touching it. This method is especially useful in oozing from bone surfaces. Here the same result may be accomplished by an apparatus commonly used by artists in making burnt woodwork.

It is not often necessary to resort to this method. The application of a gauze pad wrung out of very hot, or even boiling water will usually accomplish the same end in a more convenient manner. In using hot moist pads

it is important to leave them in place without change for several minutes at a time. If applied to the oozing surface with pressure the effect is more satisfactory.

APPLICATION OF SUTURES

It is often necessary to apply catgut sutures to bleeding surfaces en masse because the bleeding may be so diffuse that it is quite impossible to catch each of the innumerable small vessels separately. In these cases a suture is applied around areas and tied in the form of a purse-string, or two opposing surfaces are sutured together, the pressure thus caused upon both surfaces preventing the diffuse hemorrhage. If the wound is near some of the larger blood-vessels it is, of course, important not to injure these structures in passing the sutures through the deep tissues.

EXTERNAL PRESSURE

In many cases in which large wound surfaces are produced, as, for instance, in excision of the breast, it is important to apply large pads of cotton over the surface when the wound is dressed, and to hold these in place by the application of soft, gauze, rolled bandages. The uniform pressure will result in stoppage of oozing from the surfaces of these large flaps which may be but very slight from any one point, but which would result in the loss of a large amount of blood from the entire surface, were this not prevented by the careful application of pressure by a properly adjusted dressing.

POSITION OF THE EXTREMITIES

If there is any difficulty in controlling hemorrhage in the extremities this can always be accomplished by elevating the part to its fullest extent and applying pressure at the point of bleeding until the blood-vessel can be ligated in the wound, or above it. This is true especially in the troublesome hemorrhage due to injury to the plantar or the palmar arch. We have encountered such cases in which recurrent hemorrhages have greatly distressed both physician and patient, but where permanent relief was at once obtained upon elevating the extremity, applying a small compress and keeping the part raised for a week or ten days. It is, of course, important not to permit these patients to lower the extremity too soon, because the pressure ensuing is often sufficient to force out the occluding blood clot unless it has had time to become fairly well fixed.

INJURIES TO THE WALLS OF BLOOD VESSELS DURING OPERATIONS

Occasionally a portion of a blood-vessel wall is intentionally removed during an operation, but much more commonly this happens as an accident, especially to the large veins in operations upon the neck, the axilla or the groin. In these instances it is well to carefully compress the vessel above and below the injured point. If the opening is very small it is often possible to grasp it with one or two hemostatic forceps with rounded ends and to apply a fine, strong ligature. Usually this will close the opening and the result will be precisely the same as after ligating a lateral branch of a large vein. Under such circumstances it is important to apply the dressings very snugly in order to support the ligature in case of increased intra-venous pressure due to vomiting after the operation.

Repair of blood vessels. Should the opening be too large to be closed by this method it may be sutured by means of a very fine needle threaded with smooth catgut. It is best to use the catgut double because the double strand will more perfectly fill the needle punctures. It is well to wait a few minutes

after the sutures have been applied before removing the pressure at either side of the wound, in order to permit the needle punctures to become adherent to the sutures. The distal compression should be released first, and a little later that on the proximal side. The sutures are applied according to a method later to be illustrated in connection with intestinal sutures. It seems best to insert the sutures so that they will not penetrate quite into the lumen of the blood vessels for fear of producing thrombosis.

At the suggestion of McAlester, Guthrie has introduced human hair as a substitute for catgut and silk in suturing blood-vessel walls, and his plan seems to be worth imitating. He uses a number 12, 14 or 16 cambric needle which can be obtained at dry-goods stores, choosing the small-eyed variety. He threads this with a long human hair and sutures as described above. The hair is sterilized by boiling in paraffin oil. This suture is very fine and still quite strong enough.

If the vessel has been cut off entirely it may be united by these sutures, or the two ends may be threaded upon magnesium rings and these can be forced against each other by means of fine, strong, catgut sutures.

In all of these operations it is important to exercise great care not to injure the intima in compressing the vessel above and below the wound. Various forceps have been invented for this purpose and metallic bands have been recommended by Halstead and by Matas. Many surgeons apply temporary ligatures while others always have the bleeding controlled by digital pressure.

So long as the vessel walls, and especially the intima, are not injured it does not matter what method is chosen.

In all operations near large veins it is of the utmost importance to exercise great caution to prevent tearing these structures, as the walls of even very large veins are frequently delicate and consequently very easily ruptured. It is best first to expose these veins and then to work away from them.

VESSELS SEVERED NEAR THEIR ORIGIN

Especial care must be followed in ligating vessels which have been severed near their origin. A careless assistant can easily pull the remaining portion of a vein out of the side of the large vein into which it empties, thus leaving a lateral defect in the latter which can often be repaired only with difficulty by one of the methods just described. To make things worse he may make frantic efforts to stop the resulting hemorrhage by wildly applying forceps to the side of the vein, usually either increasing the original defect or making new ones. In these accidents it is well always to remember that such an opening can be closed at once, without the use of any force, by simply placing the end of a finger over the opening. Then the vessel can be digitally compressed above and below the opening and forceps can be applied at leisure, or the vent may be closed with sutures.

After applying forceps to vessels near their origin it is well always to ligate at once in order to prevent harm from traction upon the handles of the forceps.

SUTURING OF DEEP WOUNDS

It is important in all deep wounds to have the surfaces absolutely in apposition in order to prevent the formation of spaces in which quantities of blood and serum may accumulate.

In most instances these accumulations will absorb or become organized, but there is always a possibility of infection through the circulation or a slight infection at the time of operation, which would not be sufficient to cause a local disturbance if no good culture medium were provided, and

which may cause some delay in the ultimate wound-healing in case spaces are left between the wound surfaces.

For this reason it is well to unite the deep layers by means of fine, catgut sutures because union takes place within a few hours and then the support will no longer be needed.

Caution against tight sutures. It is important to bear in mind, however, that nothing is more favorable for the location of infection than necrosed areas due to the application of sutures drawn too tightly. It is consequently best to draw these deep, buried, catgut sutures only just sufficiently firm to bring the surfaces together, but not firmly enough to cause pressure-necrosis.

By using for this purpose fine catgut prepared by any one of the methods already described, preserved in the iodoform-ether-alcohol mixture, the results are most satisfactory.

All unabsorbable suture material, like silk, silkworm gut, linen, silver, aluminum or bronze wire is to be condemned for this purpose. It has no advantage over the catgut and has the very serious disadvantage of causing long-continued irritation, ultimately necessitating a removal of the suture in many cases.

The material least harmful among these is very fine silk because this will in time become absorbed.

SUTURING OF SUPERFICIAL WOUNDS

In closing superficial wounds two kinds of sutures must be considered, viz., those that are used for the purpose of coaptating the wound edges, and those that are used for the purpose of overcoming tension or for protecting the wound against sudden strain, as in case of sneezing, coughing or vomiting. Many wounds are located so that there is no tension at all and in these only the coaptation sutures are needed.

TENSION SUTURES

Where there is severe tension it is important to study the degree thereof and the direction, and to adjust the sutures to the best advantage of the existing conditions. For this purpose strong silk or wire sutures are most suitable. The ends which rest against the skin may be attached to lead plates or pledgets of gauze. Since the introduction of the Thiersch method of skin-grafting, however, the tension suture is employed to a much slighter extent than formerly, because in most cases it is better to leave a surface to be covered by skin-grafts than to put too much tension on the flaps.

In all cases in which there is tension it is well to leave the edges a few millimeters apart at the time the wound is closed, as this will enable the lymph to escape from the edges of the wound thus preventing the edema which is certain to occur if the wound edges are closely sutured, and this edema favors necrosis of the flap. This is especially to be borne in mind in all cases in which there is arterio-sclerosis, and still more in those suffering from diabetes.

Wherever it is possible to plan an operation so that there will be no tension this should be done, and in no case should sutures be tied tightly enough to cause pressure-necrosis.

PRINCIPLES OF SUPERFICIAL SUTURES

In suturing superficial wounds certain principles must be observed without regard to suture material.

1. Sutures should be drawn just tightly enough to bring the wound edges together, but not sufficiently tight to cause pressure-necrosis.

2. Allowance should be made for the edema which always occurs a day or two after the operation.
3. The bite of the needle should be equal on both sides of the incision, both as to depth and length of stitch.
4. The tension should be disposed of by one set of sutures, the coaptation by another which may, however, also be accomplished by making one deep and one superficial stitch alternately.

METAL CLIPS

Many different metal clips have been invented and some of them are quite as satisfactory as the various sutures which have been described; they are, however, much more expensive and this element must be considered, especially in hospital work. Results are no better than with sutures, consequently their employment must remain entirely a matter of personal choice.

NON-ABSORBABLE SUTURE MATERIAL

The most useful suture materials of this class consist of silk, linen, horsehair, silkworm gut, silver, bronze, or aluminum wire. The first, second and third may be impregnated with celloidin or with paraffin to prevent the entrance of pus. The others are all impermeable. All of these materials may be used both as superficial, removable sutures, or they may be buried, but in the latter case they are certain to cause much annoyance both to the surgeon and to the patient, because in the event of infection they will later have to be removed and usually the patient will have this service performed not by the surgeon who applied the sutures originally, but by some one who never uses unabsorbable buried sutures, or by another who has for some time abandoned this practice.

If applied as buried sutures it is important not to include muscles in the bite of the suture, as the contraction of the muscles is very likely to cause these unabsorbable sutures to act as irritating foreign bodies.

Each of these materials has its advocates because of some especial virtue, such as pliability, ease of application, non-absorption of wound secretion, slight antiseptic qualities as with silver wire, slight elasticity, as in case of horsehair, cheapness, as in case of silk, linen and horsehair.

As a matter of fact if applied without tension all of these materials are very satisfactory. The various conditions under which one or the other is preferable will be mentioned in connection with the particular operations.

ABSORBABLE SUTURE MATERIAL

Catgut is the only absorbable suture material that needs to be considered because, if properly prepared, it fills every requirement. It is more expensive than silk, linen and horsehair, and should consequently not be used where these will serve the same purpose. It is quite as satisfactory in every particular as kangaroo tendon, and vastly superior in many respects, and should therefore displace the latter entirely.

If the methods of preparation and preservation described heretofore are carefully carried out this material is absolutely reliable both as regards tensile strength, time required for absorption and absolute asepsis. These methods are moreover so simple that any honest person can have perfect results and there are many manufacturers who supply the catgut prepared so that it can be used without any fear of infection from this source.

AFTER-TREATMENT OF ASEPTIC WOUNDS

Don't meddle. It is most important to bear in mind that the less one meddles with aseptic wounds after they have been carefully sutured and dressed, the more certain one can be of obtaining primary union. If the sutures have not been drawn too tightly there will be no pressure-necrosis and consequently the staphylococci which are always present in the skin will not find any culture medium. It is well to dress the wound on the fifth to the seventh day, being careful not to pull the united wound edges apart by rough handling. Then it is well to paint the line of suture with compound tincture of iodine and remove the superficial sutures, then once more paint the surface with the same solution, and reapply an aseptic dressing, leaving the deep sutures to be removed later, as indicated in connection with the various operations. The tincture of iodine seems to obliterate the little suture marks.

Support by strapping. The deep sutures removed it is well to apply a rubber adhesive plaster to each side of the wound and about two inches away from its edge. These straps should contain a number of tapes, about one for every four cm. of length of wound. These straps are applied and left untied for a day or two in order to secure perfect attachment to the skin, then the tapes, which should be so arranged as to be opposite each other, should be tied sufficiently firm to remove all tension from the wound itself. In this way it is possible to obliterate the scar almost completely. Unless this precaution is taken the wound frequently becomes drawn out into an ugly, broad, white, disfiguring mark.

Unless the sutures are tied loosely each one leaves a transverse mark across the wound, which is also likely to be very unsightly.

Occlusive and antiseptic applications. Various substances have been recommended for application to the wound for the purpose of preserving asepsis and preventing the formation of ugly scars; of these flexible collodion and concentrated tincture of benzoin are the best. Of the various powders those that are non-irritating and odorless, and contain some form of iodine, are the best. Most of these are made under some patent, and as wounds heal quite as perfectly without their use it does not seem proper or necessary to mention them specifically.

Avoid any unnecessary manipulations. It is very important never to crush or manipulate wounds at the time of dressing. Inexperienced assistants seem to have an insane desire to feel of wounds and there can be no doubt that the gratification of this desire results in the infection of many wounds which would otherwise heal by first intention.

Removal of sutures. In removing the superficial sutures great care should be exercised not to separate the delicately-united wound-edges. It is much better not to touch these sutures for two weeks after they have been applied than to disturb the edges in the least while removing them early in order to prevent the stitch marks. A careful assistant, with reasonable patience can, however, remove these superficial sutures with proper forceps and scissors without fear of causing this disturbance.

AFTER-TREATMENT OF PRIMARILY SEPTIC WOUNDS

Every surgeon encounters many wounds that are primarily septic in cases which come to him because of the presence of a septic condition.

In these the following results must be obtained:

1. The accumulation of septic material must be evacuated.
2. Provision must be made against reaccumulation of septic material.
3. Absorption of septic material must be prevented.

The first of these conditions is accomplished by free incision, which must of course be varied according to the character and the location of the infection. The second object is accomplished by the use of drainage tubes or tampons, which must again vary according to conditions, and this will in turn accomplish the third object. These steps will cause the lymph stream to pass away from the infected tissues carrying with it the septic material which is deposited upon the dressings. Thus the infection of tissues hitherto free will be prevented in a physiological way. In the meantime if the infection is in an extremity venous congestion should be prevented by elevating the part, and progress of the infection through the lymph channels should be prevented by placing the part of the body affected perfectly at rest.

The elimination through the lymph stream can be stimulated by the application of warm, moist dressings. It is possible that by adding mild, non-poisonous antiseptics, like boric acid and alcohol, to these dressings that they will further aid the processes of disinfection. Kahlenberg has demonstrated that boric acid is rapidly absorbed when applied in aqueous solution externally, whether in sufficient quantity to have a beneficial effect has not been proven although clinical observation seems to bear out this idea.

Later on the healing can be accelerated by stimulating the wound surfaces by the application of compound tincture of iodine, or two to ten per cent. solution of nitrate of silver, or any one of a number of other substances. In case of septic cavities the application later on of Beck's bismuth paste,—one part of arsenic free bismuth subnitrate in two parts of vaseline,—is followed by excellent results.

This should be applied at first each day and later on less frequently, and should be kept in contact with the deep surfaces by transfixing the external wound.

AFTER-TREATMENT OF CLEAN WOUNDS BECOMING INFECTED

Prevention. Of course benefit must come chiefly from prevention, and this must depend largely upon the organization of a reasonable system, and in this system every person must fully appreciate the fact that he carries an important portion of the responsibility. In this the permanency of service is a most important matter so far as the assistants are concerned, and permanency of methods is equally important, chiefly because of the fact that this secures conditions in which possible flaws or weak points are known and can be guarded against, and because any neglect in carrying out the methods can be more readily recognized than when changeable plans are employed.

Whenever there is any evidence of infection occurring in a wound which was primarily clean it is well at once to remove several sutures, especially at points showing redness, and to apply a large, hot, moist, antiseptic dressing consisting preferably of one part of alcohol and two parts of a suturated aqueous solution of boric acid to the surface, and to cover this dressing with some impermeable substance like gutta percha tissue or oiled muslin. These wounds should not be manipulated. If the infection does not subside at once then the wound should be opened a little further, or in severe cases it may become necessary to open the wound throughout.

From this point on the treatment should be the same as in the cases just described. Usually the infection, however, subsides promptly upon taking the first step mentioned above. In each case the cause should be determined. It is usually a slight error in technic which can readily be corrected to the benefit of patients operated on subsequently.

Post-operative rupture of wounds. It occasionally happens that an abdominal wound ruptures, due to extreme intra-abdominal pressure from

excessive coughing or vomiting, or during gastric lavage. This accident can be prevented by always placing a sufficient number of silkworm-gut sutures in the wound and tying each with a surgical tie at least three times. It is important also that the fascia be not sutured too tightly so as to cause pressure-necrosis and thereby weaken one of the strongest structures in the abdominal wall. By relieving cough with sedatives, and vomiting by gastric lavage after giving a hypodermic injection of one-fourth grain of morphine one-half hour before beginning gastric lavage, the primary causes of rupture can be avoided. It is also well to spray the throat well with 4 per cent. solution of cocaine before attempting to introduce the tube, in order to obviate retching and gagging.

In order to suture a wound following a post-operative rupture, the patient is anesthetized, the abdominal contents replaced gently, and silkworm-gut sutures applied through all layers about 1.5 cm. apart along the entire wound. No catgut or other sutures should be used. In this way the wound will heal kindly, unless the peritoneum has been infected or the intestines have been exposed too long or too severely. The mortality of post-operative rupture is from 20 to 30 per cent.

SURGICAL INSTRUMENTS

It is well to become accustomed to the use of as few instruments, and of as simple construction as possible, as in this manner the surgeon becomes so familiar with each instrument that he can use it with the same facility that the skilled artisan shows in the use of his tools. This enables the surgeon to reduce the time required by the operation to a minimum, and at the same time each operation when completed is technically as nearly perfect as it can be.

Personal efficiency. During the past few years very extensive studies have been made for increasing the efficiency in almost every industry in this country. A systematic plan has been employed, known as the Taylor system, by means of which the necessary and the useless or harmful motions have been determined by exhaustive motion studies. Then the results of these studies have been employed for the purpose of eliminating useless motions and systematizing the useful motions with the general result that the efficiency of the work has been enormously increased, as shown by the greatly increased production with the expenditure of the same amount of energy.

Similar studies as applied to surgical operations have shown that in general the percentage of efficiency is exceedingly low, probably because no one has given the matter any attention heretofore. Of course it must be plain to every one that now the subject has been brought to our attention, we will soon eliminate to a great extent these useless motions and thus greatly increase our efficiency, with the result that without any haste the time of each operation will be greatly reduced. This will in turn reduce the amount of anesthetic given, the amount of unnecessary trauma, the time the tissues are exposed to the possibility of infection, and the time during which blood may be lost through oozing from exposed wound surfaces.

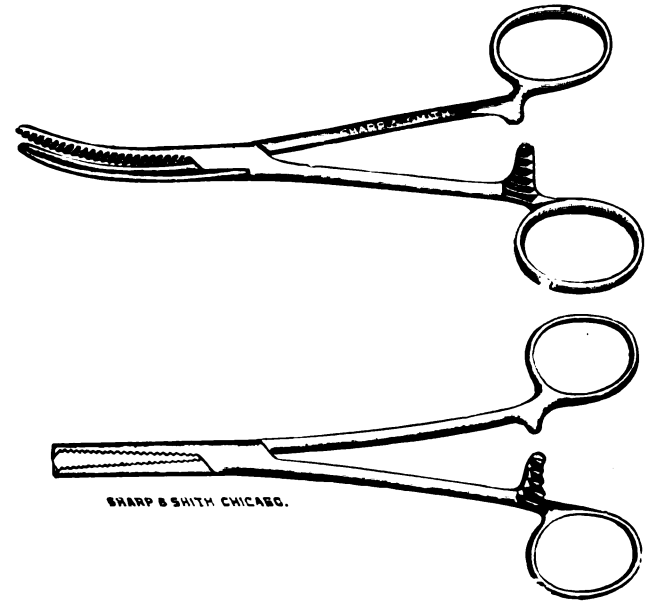
In the meantime, to accomplish this end instruments will have to be standardized precisely, as it has been necessary to standardize tools in factories, selecting those patterns which enable the artisan to increase his efficiency, at the same time reducing the number and variety to a minimum.

The opportunity young surgeons now have for increasing their efficiency while acting as hospital assistants will undoubtedly greatly aid in developing this departure.

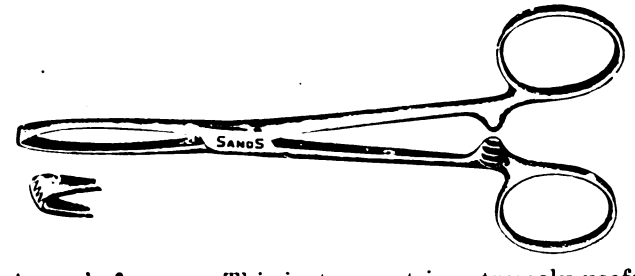
It may be repeated that in almost every modern mechanical or technical industry an attempt is being made to standardize the implements employed with the result of greatly increasing the efficiency. In surgery this has not been done systematically, although the practice of the progressive surgeon to visit many clinics and to select therefrom not the most unusual, but the most practical instruments and procedures used by the most successful surgeons has resulted in the general adoption of many good aids and devices, so that there has resulted, in a measure, a natural standardization of the instruments which are used in the greatest number of cases by many surgeons.

In order to satisfy a request which has frequently been made we herewith include a list of instruments of this class which we have found satisfactory after long-continued use.

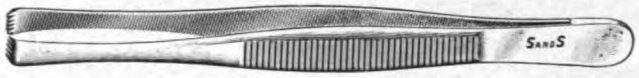
Kocher hemostatic forceps and Kelly hemostatic forceps. These instruments have a box joint and are for this reason true in the apposition of the jaws and



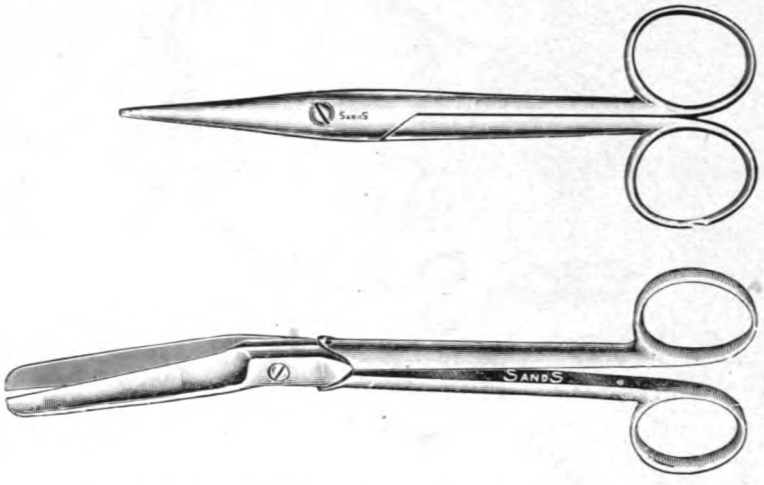
can be used to compress arteries grasped with the end of the forceps, or pedicles or broad surfaces may be grasped between the long serrated jaws. These instruments can be used in two sizes.



Allis' anastomosis forceps. This instrument is extremely useful in grasping and holding fine edges, as in suturing intestines, stomach, gall-bladder, etc.

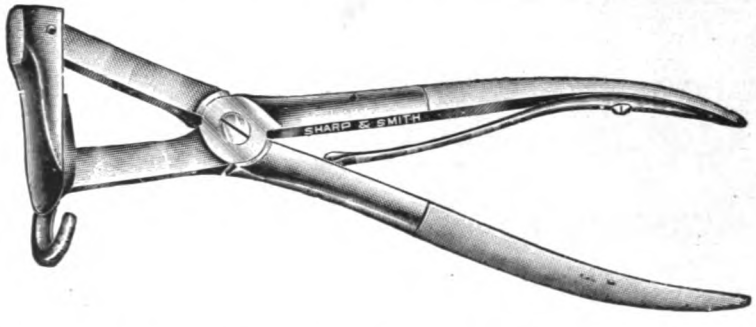


Stone's tissue forceps. It is well to select one form of tissue forceps and then adhere to its use. This form has been most satisfactory in our practice.



Scissors. Aside from the usual straight and curved scissors it seems worth while to direct attention to Mayo's dissecting scissors with blunt points to prevent injuring nerves and other delicate structures, and the very convenient flat-angle scissors of Ferguson.

Mayo Robson's gall stone scoop is useful wherever a blunt scoop is indicated.



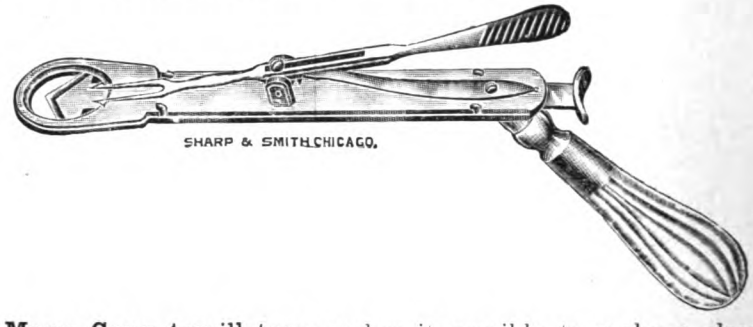
Shoemaker's rib shears are powerful and can be placed around the rib without danger of injuring the pleura.

A simple soldering iron which can be purchased at any hardware store is often useful. It can be heated in the gas flame of a Bunsen burner or a large alcohol lamp, or by placing in the hot coal of an ordinary stove or grate fire.

It is important to have an easily adjustable lamp on a head-band. This is often of very decided assistance.

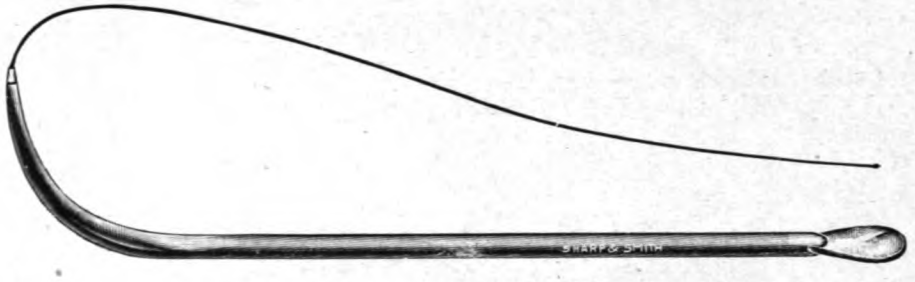
Whitehead's mouth gag keeps the mouth open uniformly without danger to the teeth.

Gottstein's adenoid curette is a useful instrument.



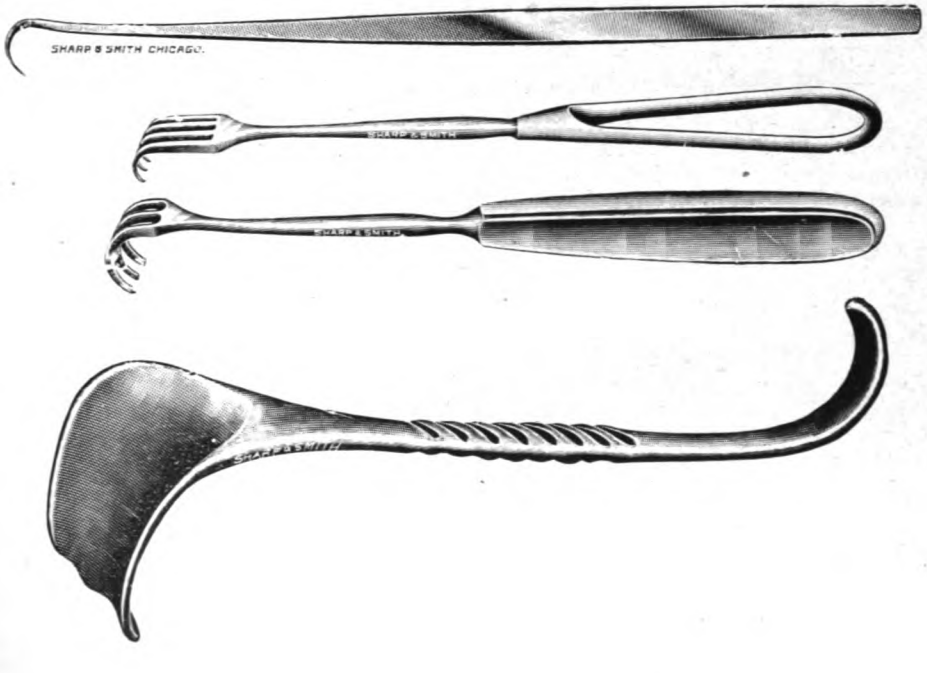
The **Moses Gunn tonsillotome** makes it possible to make a clean tonsillectomy after first loosening the tonsil. The spearlike fork elevates the tonsil

so that it can be cut off at its base. Except in the hands of an expert who can accurately judge the depth to which one should go, it is better to substitute one of the various wire snares for this instrument.



La Fort's urethral sounds with filiform, being conical in shape are exceedingly satisfactory instruments.

A small-sized **Emmet's trocar** is useful for emptying distended gall-bladders, cysts, abscesses and hydrothorax; the lateral branch of the canula prevents soiling of surrounding tissues.

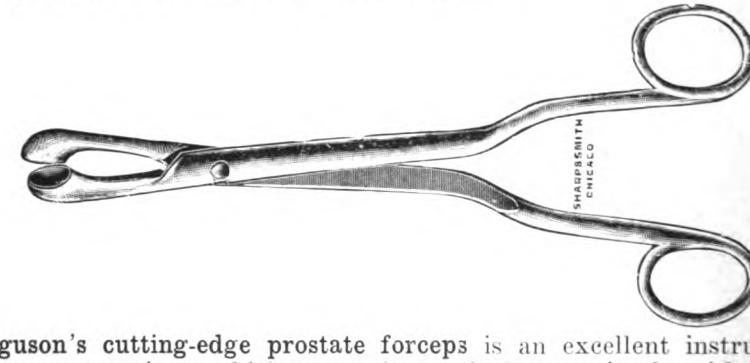


Collins' retractors are very convenient. They are not heavy enough to permit crushing of tissues but sufficiently strong to retract the edges of large wounds.

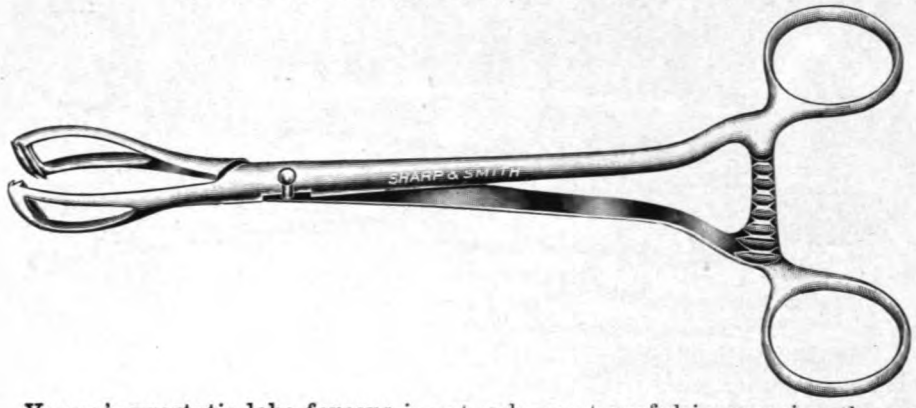
Thomas' prostatic spoon. This instrument was invented for the purpose of elevating the prostate gland in suprapubic prostatectomy by inserting the spoon-like end into the rectum, but it can be used most satisfactorily in many other operations, for instance, as a retractor in gall-bladder and common duct operations and for the purpose of keeping the intestines out of the way in closing the abdominal incision.

The accompanying cut shows a nail-cleaner which does not injure either the nail nor the soft tissues, but thoroughly cleanses the space about the nail.

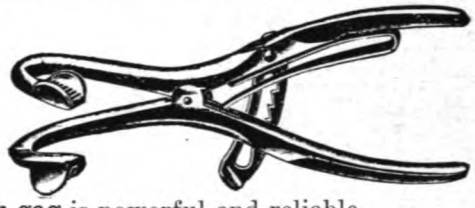
The self-retaining catheter with the mushroom-shaped end is useful not only in draining the female bladder but also the gall-bladder or any other cavity for which a self-retaining drain is desired.



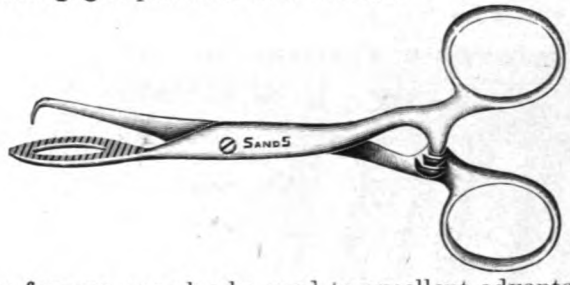
Ferguson's cutting-edge prostate forceps is an excellent instrument for cutting away any tissue which cannot be reached conveniently with scalpel or scissors. The curved form is usually to be preferred.



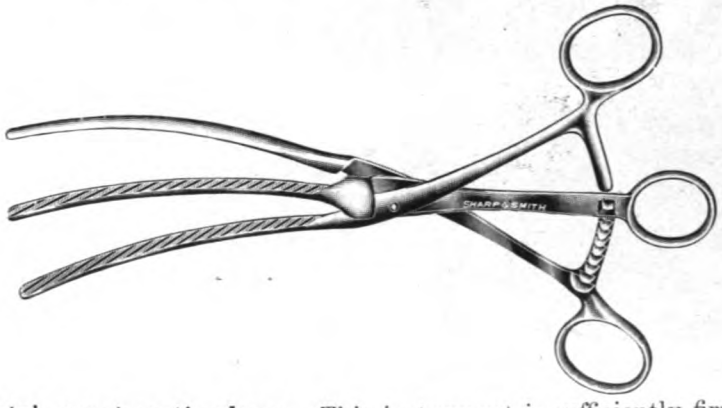
Young's prostatic lobe forceps is not only most useful in grasping the prostate but in many other operations it has a distinct field of value.



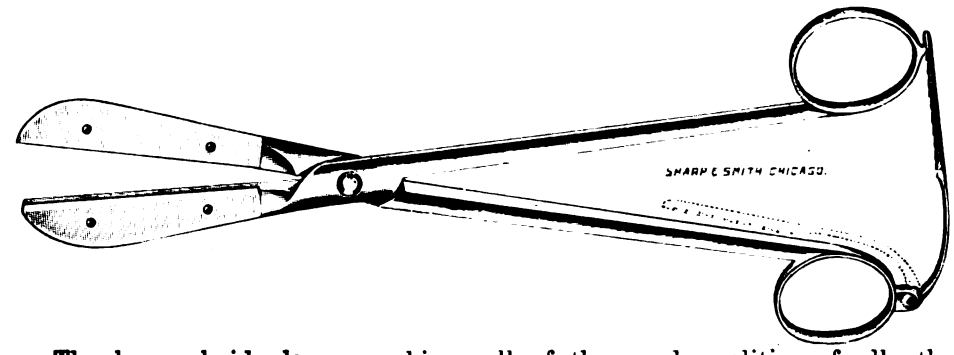
Denhart's mouth-gag is powerful and reliable.



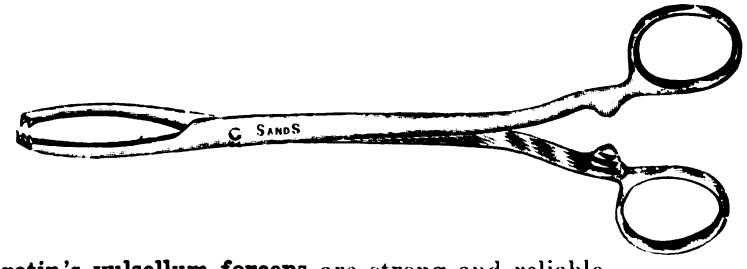
Senn's tongue forceps can also be used to excellent advantage for the purpose of holding scalp and bone flap together in osteoplastic resection of the skull.



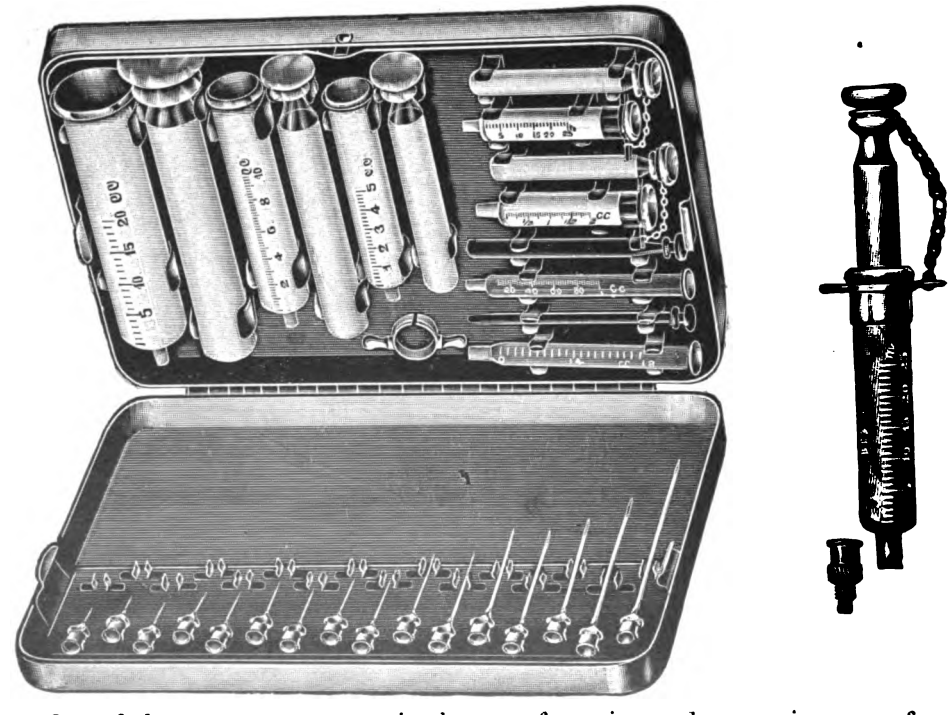
Linnartz's anastomotic clamp. This instrument is sufficiently firm to hold stomach and intestine in position without danger of injuring any of the structures.



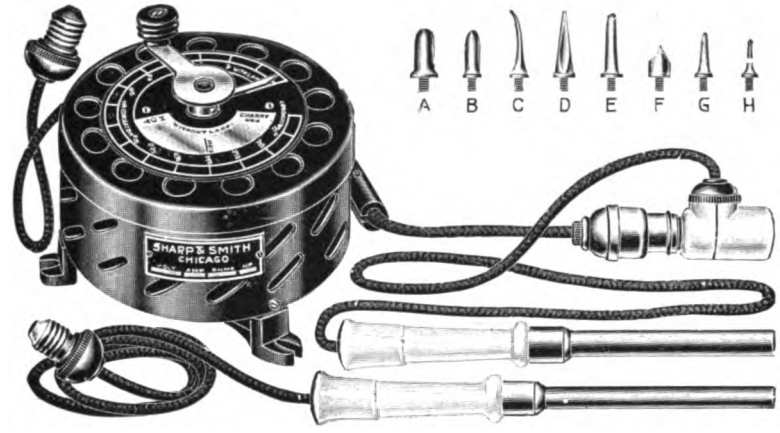
The hemorrhoid clamp combines all of the good qualities of all other clamps, together with great convenience because of the lock at the end of the handles.



Henrotin's vulsellum forceps are strong and reliable.



One of the great annoyances in the use of cocaine and novocain comes from being offered unreliable syringes. By having a set of Luer's all-glass syringes this annoyance is eliminated.



J. F. Percy's improved electric cautery outfit, with improved rheostat.

PART II

SURGERY OF THE HEAD

SCALP—ANATOMICAL CONSIDERATIONS

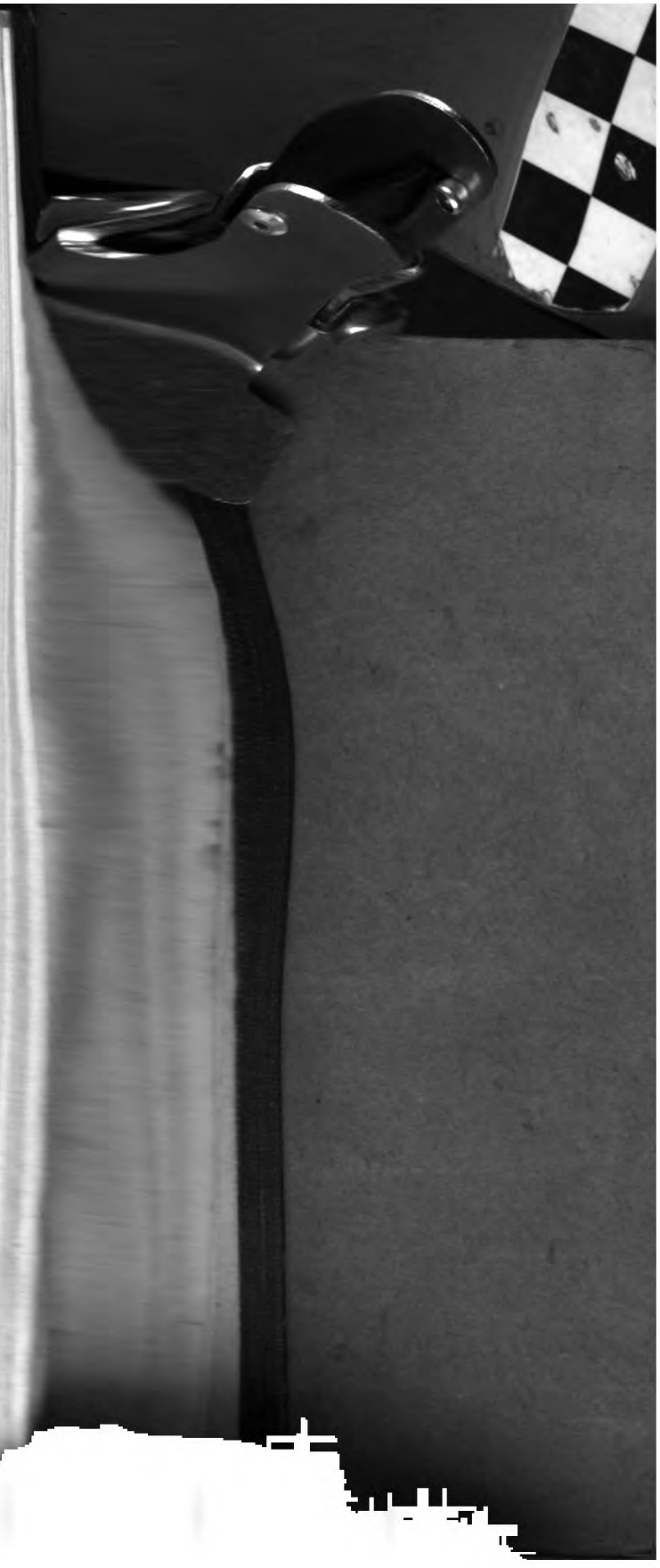
Anatomical considerations. The scalp with its hairy covering serves as a protection for the skull. The skin contains many sebaceous glands, and is very richly supplied with blood vessels, while the superficial fascia, the galea aponeurotica, the subaponeurotic connective tissue, and the periosteum, are less richly supplied. The movement in the scalp is permitted by the laxity of the connective tissue in the subaponeurotic space. The blood vessels in the skin are held rather rigid. When they are cut, they cannot retract, or contract, and hemorrhage is therefore liable to be rather profuse.

Infection favored by location. In considering scalp injuries it is important to bear in mind the fact that the conditions in this location are especially favorable for the occurrence of infection, and that it is especially in persons who are most liable to scalp injuries that the conditions are most favorable for infection, primarily because working people, and notably those working among horses and cattle and on the streets, are certain to have unclean scalps, and, secondly, the dirt with which they come in contact is most likely to contain pathogenic micro-organisms, of which the pyogenous staphylococci and streptococci are most numerous. In persons working among horses the tetanus bacillus is also frequently present. It is consequently proper at this point to refer to the matter of disinfection of the scalp, as this is of the very greatest importance, even though there may be no fracture of the skull. The scalp is likely to contain the streptococci of erysipelas, and this infection may extend through the skull by way of the veins—giving rise to a septic meningitis. In our experience this has happened in a number of cases in which the injury was due to a blow with a blunt object, such as a brick or a piece of iron, or anything hard or heavy. The disinfection in these cases should be just as thorough as though an operation were contemplated; and it is well afterward to apply a moist, antiseptic dressing of some kind and cover with some impermeable material, such as gutta percha, in order to complete the disinfection. The sooner this is accomplished after the time of the injury the better. It is unfortunate if it be postponed until the tissues have become edematous as a result of infection.

In spite of the fact that there is such a great chance for infections in the scalp, it is a well known fact that recovery from infections is fairly rapid. This is due to the facts that the skin is so richly supplied with blood vessels and can combat the infection, and that the skin is so compact that it is difficult for an infection to gain an entrance.

In these cases the amount of hemorrhage has usually been so considerable that the hair is thoroughly saturated with blood.

Antiseptic measures. If the wound is fairly clean-cut and not very large it usually suffices to wash the scalp thoroughly with soap and hot water, then to shave away the hair for one or two cm. beyond the edge of the wound in all directions and then to wash the surface with strong alcohol and with one



to one-thousand corrosive sublimate in hot water; then again with strong alcohol and finally to mop the wound and the surrounding scalp with strong compound tincture of iodine.

If the wound is very small and if one is certain that there is no fracture of the skull it is often not necessary to shave away any of the hair if the scalp is thoroughly treated according to the method just described.

On the other hand, if the scalp has been badly crushed and if the wound is extensive, and especially if there is a fracture of the skull, it is often best to shave the entire head so that in the manipulations which will be required in treating the conditions found, there may be no danger of carrying infectious material from the remaining hair to the wound and to the meninges.

Application of tincture of iodine. Recently disinfection without preliminary scrubbing by saturating the dry surface with strong tincture of iodine, or 10 per cent. of iodine dissolved in benzine or in chloroform, has been advocated. In cases in which the wound has been kept dry, the results seem to be better by simply using the iodine than by washing with soap and water and antiseptics.

Clean-cut scalp wounds. When the wound is clean-cut and there is no undermining of the scalp, it is well simply to apply tincture of iodine to the wound and to the surrounding scalp, and place just a sufficient number of sutures to secure coaptation, but no more, in order to permit the serum to escape between the sutures. This will insure rapid healing, if there is a slight amount of infection, because the blood supply is very abundant and the serum escaping between the sutures will eliminate safely a considerable amount of septic material.

When the tissues are undermined. If the edges of the wound are undermined the wound should be enlarged to a point just beyond the undermined portion, tincture of iodine applied and then sutured, with a little space left open at each end for drainage. If the undermining is extensive it is well to make one or more small incisions at the base of each flap caused by the undermining, and in bad cases to draw a small drainage tube, or strands of silkworm gut, or folded gutta percha tissue, through these openings to facilitate drainage. If tincture of iodine alone has been used for disinfecting the wound it should be covered with a plain dry sterile gauze dressing. On the other hand, if the wound has been washed with soap and water and the usual antiseptics, it is desirable then to cover it with a hot moist dressing composed of gauze saturated with a mixture of three parts of saturated boric acid solution and one part of alcohol. Some impermeable substance, like gutta percha tissue or oiled silk, is placed over this and cotton and a bandage over all.

Infected scalp wounds. It frequently happens that scalp wounds are sutured hurriedly, without sufficient cleansing, directly, or some time after their occurrence, or that they are not cared for at all for some hours, or even days, after their infliction, and that when they finally come under the attention of a surgeon infection has taken place, which may be of any degree of severity, from the slightest infection to a degree so severe that the patient may have a temperature of 105°, or even be unconscious.

In these severe cases it is wise to invariably remove all of the sutures and to open up the wound widely. Upon doing this we have found all kinds of objects, like hair, straw, splinters of wood, sand and dirt and many other things sewed up in such scalp wounds. In these cases the wound should be enlarged to the extent of the undermining and a number of small incisions made at the base of each flap. The space underneath the flaps should then be loosely packed with moist gauze and the entire scalp covered with the hot moist, antiseptic dressing previously described. This should be renewed daily until the sepsis has entirely subsided and then the edges of the wound should be sutured loosely and dressed as a clean scalp wound.

Immunizing tetanus antitoxin. If the wound has been soiled with street dust or with garden earth, or if the patient has recently come in contact with horses, from 1,000 to 3,000 units of tetanus antitoxin should be injected subcutaneously, and repeated twice at intervals of twenty-four hours. If the scalp wound is in the vicinity of the external auditory meatus it is advisable to place a few drops of strong compound tincture of iodine in the meatus, so that all parts of its surface will be covered with this remedy, and after half an hour the ear should be filled with a ten per cent. solution of carbolic acid in glycerine. This application of carbolic acid and glycerine should be repeated once or twice daily until it is certain that the wound will not have an erysipelatous complication. In case this should, however, occur the treatment should be continued in order to prevent an infection of the meninges through this channel.

TUMORS OF THE SCALP

Sebaceous cysts. The most common tumors in this region are sebaceous cysts, which may vary in size from that of a bird-shot to that of a fist, although they usually become infected before attaining extreme size and they then necrose at some point and their contents become spontaneously evacuated through the opening thus formed. They may also be injured by the use of comb or hatpin and a superficial ulcer thus may occur which usually induces the patient to give the condition surgical attention.

There is no pain in these cysts unless they are inflamed, but they are the cause of marked deformity and much inconvenience in dressing the hair.

Modern treatment and recurrence. In pre-antiseptic days there was much prejudice against surgical treatment of this condition because of frequent recurrence, and the operation was often followed by an erysipelas which sometimes resulted in the death of the patient. The first objection has now been eliminated owing to the certainty with which it is possible to remove the entire cyst wall. It is, however, to be born in mind that every sebaceous gland in the scalp is capable of forming a sebaceous cyst, and consequently the removal of the existing cysts will not prevent the formation of further similar cysts from any of the remaining sebaceous glands in the part.

It would consequently not be wise to give the patient the impression that by having the existing cysts removed he or she would in the future be free from this condition. Indeed, it has been found that persons who have once had sebaceous cysts of the scalp are especially liable to the formation of similar growths from other sebaceous glands in the same region. It is also well to examine carefully all of the portions of the scalp before the operation, in order to discover any small cysts which may be just appearing.

Early in the antiseptic era it was customary to shave the entire scalp before removing even a single sebaceous cyst, in order to secure an absolutely perfect asepsis. This is no longer necessary, as it has been found that if the plan of disinfecting the scalp that has just been described is carried out the wound resulting from the operation will regularly heal by first intention, even if no part of the hair has been shaved.

It is claimed that by simply saturating the dry scalp thoroughly and repeatedly with compound tincture of iodine for a period of ten minutes, and permitting this to become dry, that the operation can be performed safely without any further attempts at disinfection. In place of the compound tincture of iodine a ten per cent. solution of iodine in benzine or in chlorofrm may be employed.

Our own results have been so absolutely satisfactory by following the method described above that we have not undertaken to test these iodine methods, which are, however, vouched for by perfectly reliable authorities with much experience and good surgical judgment.

Technique of removal. The cysts having been definitely located, counted and marked by the application of a spot of tincture of iodine directly over the mass, the hair is separated and a sharp-pointed scalpel is thrust directly through the scalp and the underlying cyst, splitting the latter and its contents in halves. The cyst wall is much more adherent to the surrounding tissues at its most superficial point than elsewhere on its surface, hence it is wise to grasp the deepest portion of the cyst wall with hemostatic or dissecting forceps and to enucleate it from within outwards. In a fraction of a minute a cyst can be removed in this manner and unless too large a number of cysts are present the work can be done without general or local anesthetics. If there are several of these cysts present it is well to administer morphin hypodermically half an hour before the operation in order to blunt the sensibility of the patient to some extent.

The wound must be carefully examined to determine that no part of the cyst wall has been left behind. If these steps are carefully carried out it is but seldom that any portion of the cyst wall remains.

This method is much more satisfactory than the removal of these cysts by dissection, not only because of its ease and rapidity, but also because of the fact that recurrence follows much more rarely, if at all, on account of leaving portions of the cyst wall. From one to three fine catgut sutures should be introduced and a gauze and cotton dressing applied, which may be removed in one week.

Lipomati. Fatty tumors are rare in the scalp in comparison with sebaceous cysts. They resemble the latter somewhat, but are deeper-seated and less spherical in shape, presenting a more flat surface. The treatment is excision under local anesthesia. The removal can be accomplished quickly and easily by making an incision down through the growth, splitting in halves, then peeling each half out separately, the same as in removal of a sebaceous cyst.

Warts and moles. Warts and moles on the scalp are simple cutaneous hypertrophies but are apt to be quite annoying from the frequent traumatism received while combing the hair. This irritation may be the cause of the growth occasionally taking on a malignant nature. These growths should be excised. This can easily be done under local anesthesia.

Nevus. Two varieties are met with in the scalp depending upon the size of the blood vessels making up the tumor. When the growth is composed of fine capillaries it consists of a discoloration of the scalp known as a "port-wine stain," with little or no tendency to spread, usually causing no trouble other than the annoyance the patient suffers from discoloration. If it is located entirely above the hair line no treatment is indicated. If it extends onto the forehead or neck its removal is best accomplished by freezing the surface with carbon-dioxide snow.

This snow may easily be obtained from an ordinary carbon-dioxide gas tank such as used in the laboratory or soda fountain, etc. The snow is collected by placing a piece of chamois leather in the shape of a small bag about the neck of the gas tank, allowing the gas to escape rather rapidly into the bag. Snow is immediately formed. The snow is cut into convenient sized blocks, and then is held against the surface of the nevus for a period of twenty to thirty seconds. This causes a destruction of the superficial capillaries but does not freeze deep enough to cause a sloughing of the skin with scarring. Blebs usually occur on the skin following the freezing, and as these heal the skin loses its wine color. Occasionally several applications of the snow are necessary before the desired result is accomplished.

When the capillary vessels are large they form a slightly elevated, irregular

mass on the skin, which has a tendency to spread rapidly, its walls becoming thinner until ulceration occurs, resulting in severe hemorrhage. These growths should always be removed as soon as they are discovered, which is usually when they are quite small. At this time they can be excised and the wound sutured without difficulty. Later after they have increased in size it is usually necessary to cover the area with skin-grafts after the tumor has been removed. These tumors have a tendency to recur unless every portion of the involved blood vessels has been removed.

Sarcoma and carcinoma. Sarcoma and carcinoma of the scalp should be treated by wide excision, together with periosteum covering the skull. It is well to apply the actual cautery to the surface of the bone after the tumor has been removed and to secure deep cauterization of the bone in this way. The cauterized bone will be exfoliated after several weeks and the surface may be covered with Thiersch skin-grafts, unless the tumor is located at a point at which this would leave an especially unsightly deformity, in which event the scalp covered with hair from some other part of the head may be mobilized in the form of a flap of proper size and this may be slid over the defect and sutured in place. The new defect which has been formed in this manner should be covered with Thiersch grafts at once.

TUBERCULOSIS OF THE SCALP

Tuberculosis of the scalp is not a common condition. When it does occur it should be treated by the method just described for the relief of malignant growths, unless the area involved is small, in which event it is well to destroy the infected tissue with the actual cautery down to the skull, including the surrounding tissue for a distance of one cm. When the eschar has separated, the surface should be covered by a Thiersch skin-graft.

NON-TRAUMATIC INFECTION OF THE SCALP

Non-traumatic infections of the scalp should be treated like the same conditions involving other parts of the skin, but it is important to remember the fact that apparently non-traumatic infections of this region are usually due to traumatism caused by the presence of parasites, or to scratching to relieve itching of the scalp which is not kept clean. We have seen more of this since the introduction of the fantastic fashion of hair-dressing in vogue at the present time.

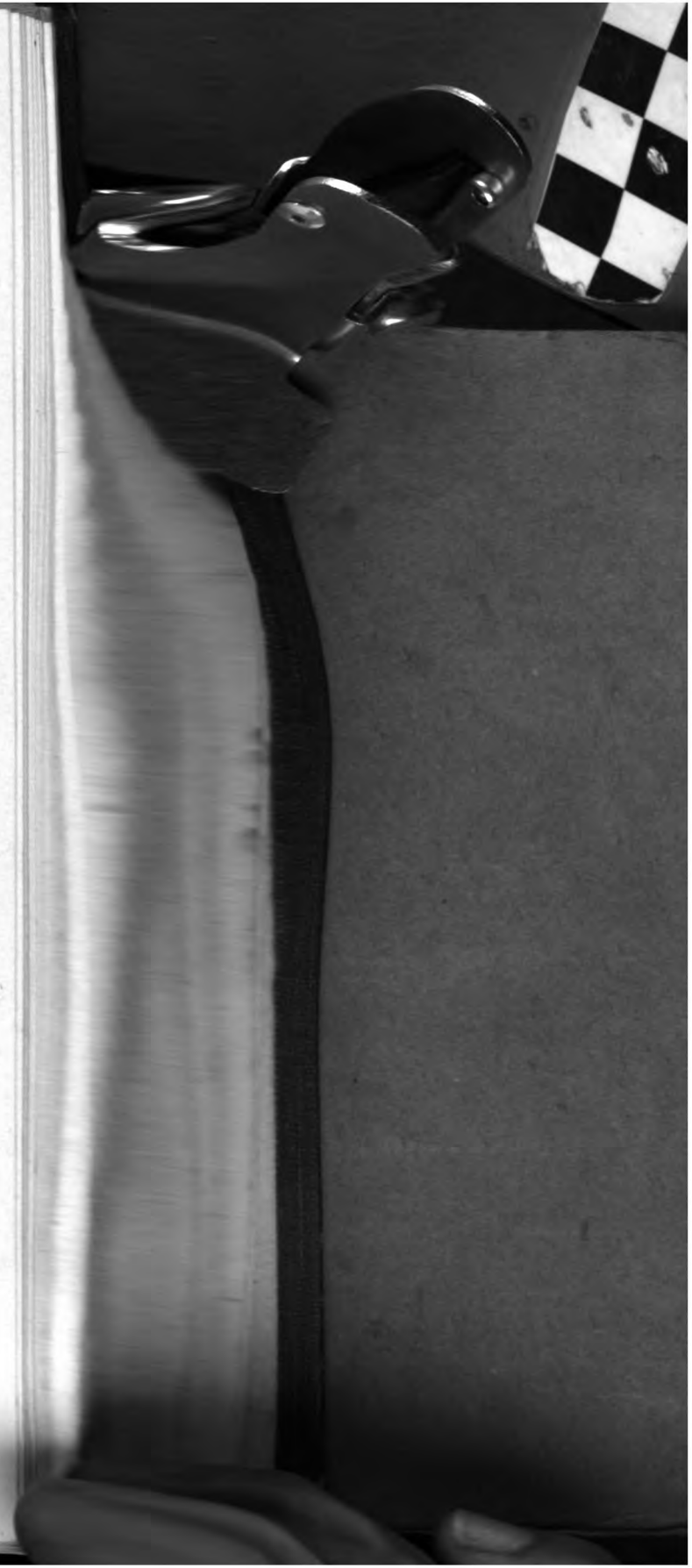
In the former case it is important as an initial step to destroy the parasites and to place the hair and the scalp in an aseptic condition, and to prevent reinfection from the material used in dressing the hair. In the second place, it must be borne in mind that it is much more difficult to use moist, antiseptic dressings effectively on hair-covered skin surfaces unless especial attention is paid to this condition, as the hair is likely to become matted together and to prevent the antiseptic fluid from touching the underlying skin.

It is but rarely necessary to remove the hair, however, if the dressing of these cases is carried out carefully and intelligently, but if left to assistants, without especial instruction, they usually progress badly.

In all other respects the treatment must be the same as for infection of other portions of the skin.

INJURIES OF THE SKULL

Diagnosis. Although injuries to the skull are more commonly associated with wounds of the scalp, it is important always to remember that the absence



of an external wound does not necessarily mean an absence of skull injury, and it is just in these cases that a diagnosis is often difficult and sometimes impossible. If a definite depression of the bone can be felt the diagnosis is easily made, but this is sometimes simulated by an abrupt depression due to the fact that the subcutaneous tissue has been crushed by a heavy, sharp-edged object, which has left a portion of the subcutaneous tissue entirely untouched, while the tissue just beyond has been so thoroughly crushed that it feels like a depression, and the sharp edge of the tissue beyond feels like the edge of the fractured bone. Whenever there is an injury to the scalp it is well to suspect a fracture, no matter how trifling the wound. All of these cases so suspected should have stereoscopic X-ray plates made, and many times fractures will be revealed where not suspected.

In case of doubt it is well to treat the general condition of the patient. Apply cold, antiseptic dressings to the scalp and watch the patient carefully for some focal symptoms.

Fracture of the skull may cause no immediate symptoms aside from the shock and temporary unconsciousness due to the accompanying concussion of the brain. The injury may consist of a single fissure with or without laceration of periosteum or dura, or both, or it may be accompanied by more or less severe depression. The bone may be driven into the substance of the brain, or the latter may be quite uninjured because of its elasticity and the character of the blow.

Of the injuries to the blood vessels a laceration of the meningeal artery at some point is most common and this is by far the most treacherous condition because of the ease with which it may be overlooked unless the possibility of its occurrence is kept very prominently in one's mind, even in connection with head injuries which at first seem so slight as to be scarcely worthy of serious attention.

The authors have recently encountered three cases of rupture of the middle meningeal artery, all of which were caused by being struck on the head by a base-ball, and none presenting any serious immediate symptoms, but each one giving an entirely different later history.

First case a boy of fifteen while playing base-ball was struck in the right temporal region by a ball. Patient was not rendered unconscious at all, was able to get up from the ground unaided, and walked home a distance of one mile. Two hours later while eating supper he suddenly developed a left hemiplegia which affected both arm and leg. Did not lose consciousness. Operation same evening revealed rupture of the middle meningeal artery.

Case 2. A young man twenty-two years of age struck in left temporal region with base-ball, fell but was not unconscious. Got up and walked home, but felt rather dazed for twenty-four hours. At end of forty-eight hours began to have convulsions occurring at intervals of two hours. Between convulsions was conscious but had difficulty in talking. Could answer questions yes or no, but did not have the power to form sentences. No other focal symptoms. Operation at end of third day revealed ruptured middle meningeal artery.

Case 3. Young man, age twenty-one, struck in left temporal region by base-ball. Fell to ground and was unconscious about five minutes. After this walked home without any difficulty, apparently as well as usual. Patient took up his farm work as usual, driving a harvester machine. He continued this work for four days, feeling well except that there was an interval of five or ten minutes each day, during which time he felt that he was "out of his head." On the evening of the fourth day, while milking a cow, he suddenly fell over unconscious and remained so for twelve hours. Two days later examination revealed no symptoms except patient was very slow in answering questions, stating that it was difficult to find words to express himself. Operation revealed rupture of the middle meningeal artery.

These cases very commonly have the following history: A patient receives a slight injury from which he recovers in a very short time, usually within a

few minutes. He is able to go to his home, but later on becomes unconscious, his pulse becomes slow, and unless relief is secured within a very short time he succumbs to the effects of intra-cranial pressure. This history is usually so clear and the symptoms so pronounced that there is little difficulty in making the proper diagnosis unless the surgeon is called too late, or if the patient's primary injury has been overlooked on account of the apparent slightness of its character.

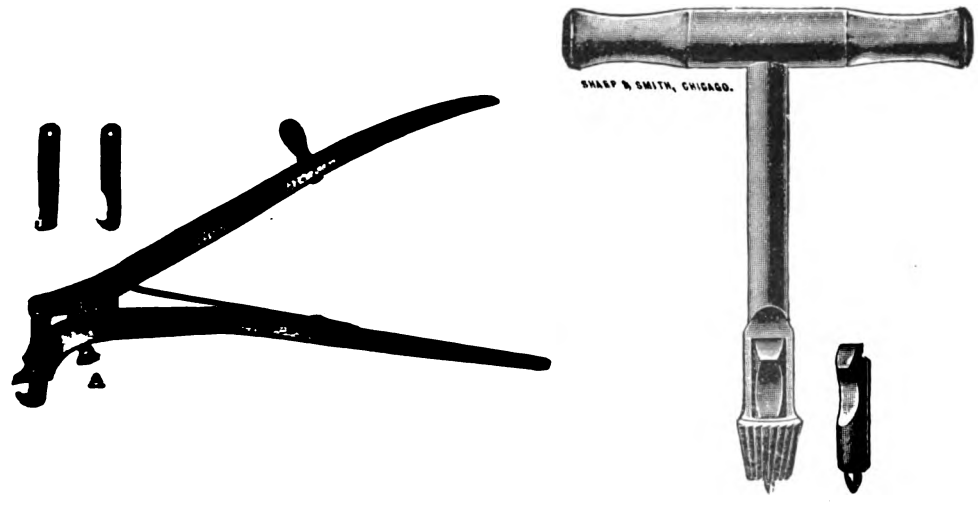
Choked disc on the same side is usually present as soon as the symptoms of pressure appear. One should always make a careful ophthalmoscopic examination in these cases.

The treatment must be applied at once, for if it is neglected the patient's condition will soon become hopeless.

In injuries of the skull when it looks like the patient is going into a state of coma on account of rupture of the middle meningeal artery, Murphy suggested an immediate ligation of the external cartoid artery under local anesthesia. This will stop the hemorrhage at once, as the middle meningeal artery is a branch of the internal maxillary artery, which is a subdivision of the external carotid. Now that the hemorrhage has been controlled, relieving the patient of any immediate danger, the surgeon can take his time to do the trephining.

LIGATION OF THE MIDDLE MENINGEAL ARTERY

The danger of infection of the meninges is greatly reduced by thoroughly shaving the entire scalp before the commencement of the operation. If only



DeVilbiss Forceps and Proper Trephine.

a small portion of the surface is shaved it is likely that during some part of the operation some one will carry infectious material from the remaining portion of the scalp to the wound and thus cause an infection, which in these cases is always serious. If the entire scalp has been carefully shaved the further disinfection is no more difficult than disinfection of the skin in any other portion of the body.

If the point of injury can be distinctly located in the course of one of the

principal branches of the middle meningeal artery, the point of operation can be determined in this manner. If this cannot be done it will become necessary to expose first one and then the other of the principal branches of this vessel, provided the first attempt fails; or it may be better to expose both branches at once by making an osteoplastic resection of a portion of the skull, covering both the anterior and the posterior branches of the middle meningeal artery. The following guide will suffice to locate these branches:

The anterior branch crosses a point one and one-fourth inches backward and upward from the external angular process of the frontal bone. The posterior branch crosses a point at which this line divides a line drawn vertically from the anterior edge of the mastoid process. An opening can be made at these points by means of a trephine one-half inch in diameter; the instrument should, however, be conical in shape so that as soon as the inner table of the skull has been perforated by it the instrument is stopped automatically from penetrating deeper and causing an injury to the dura. It is usually best to make an oval skin-flap covering the area traversed by both the posterior and the anterior branches of the middle meningeal artery, so that if the injury is not found in the anterior branch, which is most commonly the seat of trouble, an elliptical-shaped flap of the parietal bone may be cut loose by means of DeVilbiss forceps. In this way much time can be saved and the surface can be so thoroughly exposed that no error is possible.

In making the resection of the skull the size and form of the flap may be regulated by directing the instrument. A flap sufficiently large to cover the space occupied by the posterior and anterior branches of the middle meningeal artery can be cut with the DeVilbiss forceps in a very short time, usually less than ten minutes being required for this purpose. It is, however, necessary to bear in mind the technique required in the use of these forceps. The cutting portion of the forceps should be introduced through the originally provided opening, and then it should be slid along the cut which has already been made until the end is engaged under the portion of the skull to be severed. Unless this precaution is taken the work will progress very slowly. The small bridge at the base of the bone-flap is weakened by the application of a few strokes of the chisel and then it is fractured by inserting a strong chisel opposite this point and elevating the flap. The bleeding vessel is now exposed and ligated by passing about it a fine, catgut ligature threaded in a needle, the clot is sponged away, the bone flap is replaced, and the overlying skin is sutured. If there is still some oozing after the injured portion of the meningeal artery has been ligated it is wise to place a small capillary drain underneath the flap to prevent re-accumulation of blood.

CHRONIC SUB-DURAL HEMORRHAGE

Occasionally the hemorrhage from some very small ruptured branch of the meningeal artery is so slow that no immediate symptoms are discovered for days or weeks, or, as in one of our own cases, for three months.

The first symptoms may consist of only slight headaches, with a feeling of pressure in the region where the blood is accumulating. Later the pain becomes more severe, but frequently the injury to the head has been forgotten by the patient and his friends, so that the surgeon does not receive any information regarding this most important element of the history. Then pressure symptoms occur in the form of paralysis, and if the pressure is over the area of the speech center there may be at first some slight difficulty in articulation, which becomes more and more marked until complete aphasia occurs. Later the irritation caused by the pressure may result in mania.

Aside from these symptoms the typical evidences of increased intra-cranial pressure may be noticed. This usually gives rise to a diagnosis of intra-cranial tumor unless the condition is attributed to the original injury.

Treatment. The method of operating is the same as for ligation of the middle meningeal artery as regards the formation of skin and bone flaps. When the dura has been exposed it will be found to bulge and no pulsation can be detected.

An incision of the dura will evacuate either clotted blood or serum, or both. In cases in which the injury has occurred a considerable time before the operation the cavity is likely to contain only serum, which is usually colored with blood pigment. This accumulation may vary in size from a few cc. to 500 cc. or more.

It is surprising how quickly the symptoms disappear, even in cases that have suffered from cerebral compression for a considerable period, provided the increase in pressure was very gradual.

The wound in the dura should be closed with fine, catgut sutures. Some silkworm gut strands or some folded gutta percha tissue should be used for drainage from one angle of the wound and a large external dressing should be applied. In one of our cases there was a slight re-accumulation probably from secretion from the walls of the space in which the original accumulation had taken place. Simply reopening one angle of the wound very slightly permitted this fluid to escape and then the recovery progressed uninterruptedly and the patient remained permanently well.

Important to recognize the indications. It is really very important to bear this condition in mind in dealing with patients suffering from headaches and other pressure symptoms, because most of the reported cases suffered for a long time before a diagnosis was made. The condition is undoubtedly never recognized in many cases. If the fluid accumulates more rapidly these patients die from cerebral compression.

SIMPLE DEPRESSED FRACTURES OF THE SKULL

Do not delay elevating. In the treatment of acute injuries of the skull, it is important to remember that depressed fractures, although frequently not accompanied by serious symptoms at the time of the injury, are likely to result in exceedingly serious late conditions, unless the difficulty is relieved quickly after the injury. The irritation resulting from a depressed fracture frequently gives rise to epilepsy at some time after the occurrence of the injury. In order to prevent this, it is important in every case in which there is a depressed fracture to elevate this at once, which can be accomplished by exposing the seat of the fracture by an incision through the scalp, the latter having been shaved as indicated in connection with previous operations on the part. If the fracture is comminuted a small portion of the bone can usually be removed by the introduction of the sharp edge of a chisel, and with the use of this instrument, together with the sequestrum forceps, it is usually possible to adjust the portions of the depressed fracture very accurately. If this cannot be done it is safer to sacrifice some portions of the skull than to leave any depressed part to irritate the meninges.

If an injury is found in the dura this should be sutured with fine catgut. After the skull has been carefully adjusted the scalp is sutured over this with or without capillary drainage, according to the amount of oozing that remains. Care should be taken to sacrifice as little as possible of the skull, and in simple fractures fragments may be replaced with safety, although they may be entirely separated from the dura and the periosteum. In compound fractures the same plan of treatment must be pursued, with the addition of very careful

disinfection, the removal of all fragments of the skull which may have become infected in the least and the use of drainage in all of these cases.

Choice of bone chisel. In all chiseling operations upon the skull and elevation of fragments, the ordinary carpenter's chisel and a mallet, such as the ones used by wood carvers, are of the greatest convenience. Most bone chisels obtained in instrument stores are practically useless for this purpose, because they are either clumsy or difficult to handle, while the carpenter's chisel can be used with ease by any one who has the least manual dexterity. A convenient amount of bone may be cut away in a few moments with this instrument, and the form of the incision in the bone can be easily controlled. The chisels are so sharp that their use does not give rise to any severe concussion. This is especially true if the edge of the chisel is held nearly parallel with the surface of the bone. A number of chisels should be at hand, so that if any defect occurs in one it may be laid aside and another substituted at once.

COMPOUND FRACTURES OF THE SKULL

Most compound fractures of the skull are associated with more or less laceration of the brain tissue. These cases should all be operated upon at once for the purpose of cleansing the wound and relieving any irritation of the brain from the depressed fragments. In these cases it is well to tampon the wound full with sterile gauze, at once, so as to prevent the introduction of any septic material into the wound during the process of washing and shaving the scalp. After the scalp has been disinfected the gauze is removed from the wound and the skin wound is enlarged so as to thoroughly exposed the injured skull. The depressed bone should be raised and any loose pieces of bone should be removed, as the patient is less liable to suffer from late complications, such as epilepsy, than when the loose fragments are left in place. After the bone has been elevated and loose fragments removed, the wound should be irrigated with normal saline solution. Any hemorrhage from the brain should be controlled by placing a fine, catgut ligature, or by tamponing the injured area with iodoform gauze and leaving it in place for forty-eight hours. If there is no hemorrhage from the brain, the dura should be sutured with catgut. The wound is drained with a few strands of silk-worm-gut or gutta percha tissue.

PUNCTURED WOUNDS OF THE SKULL

These cases should all be treated by operation, which consists in enlarging and disinfecting the wound and controlling any hemorrhage present. In case of a bullet being lodged in the brain, it should be removed if it is situated near the surface of the brain and can be located easily. On the other hand if it cannot be seen, or located by gentle probing, it had best be left alone as it is not apt to have any influence upon the patient's immediate recovery. Later on if the patient develops any symptoms which can be attributed to the presence of the bullet, it can be located by the X-ray and then be removed with comparative safety.

FRACTURES OF THE BASE OF THE SKULL

The diagnosis of fractures of the base of the skull is often a difficult matter. These fractures usually involve the petrous portion of the temporal bone, and hemorrhage from the ear, the mouth and the nose may be looked upon as a fairly accurate diagnostic sign. In the absence of this hemorrhage it is impossible to differentiate simple concussion or laceration of the brain from a frac-

ture of the base of the skull. The diagnosis between these conditions is, however, of not so much importance, because the same expectant treatment should be carried out in either case, unless the patient develops signs of intra-cranial pressure.

The mortality in basal fractures is high and probably always will be, because many of these cases succumb within the first few hours from primary shock and brain laceration. These patients have an immediate complete coma, pupils fixed, stertorous breathing and complete muscular relaxation, and may be looked upon as being primarily fatal.

The next class comprises those in which the symptoms are not so severe, but which also have a rather high mortality. In these cases the coma is not so profound, the muscles are not completely relaxed, the pupils still react, the breathing is not so stertorous, and the pulse is slow, full and strong. A spinal puncture should be made, and if there is found to be much increased intra-cranial pressure a trephining is indicated, making a Cushing decompression operation.

There is another group of cases in which the symptoms are more mild. The patient may retain complete consciousness, or nearly so. There may be an impairment of one or more of the cranial nerves, and unequal pupils, but nothing indicating any alarming intra-cranial lesion. The progress in this group is very good and they should be treated expectantly.

There is another group in which a decompression operation is definitely indicated. It is in those cases of fracture of the base in which at first the injury is apparently not severe, and then there is a gradual or sudden increase of symptoms giving definite signs of an increasing intra-cranial pressure. It is probable that quite a number of these cases can be saved by the decompression operation.

TUMORS OF THE SKULL

Tumors of the skull, which result from invasion of tumors of the scalp, are the only ones that we have operated with permanent recovery of the patient. In these instances the most satisfactory results have been obtained by removing the tumor of the scalp, together with a large area of surrounding, apparently healthy tissue, and then applying to the surface of the entire area of exposed skull, and also to the edges of the scalp wound, large cautery irons heated to read heat, being careful, however, not to leave the iron in contact at any one point long enough to cook the underlying meninges or brain. The Paquelin cautery does not hold a sufficient amount of heat to be of as much use for this purpose as the large cautery irons, preferably ordinary soldering irons, heated in a large gas or alcohol flame.

A dry dressing is then applied to the wound, which is later dressed antiseptically until the granulation tissue causes the sequestrum to loosen, so that it may be removed easily. Then the entire surface is covered with Thiersch grafts.

PRIMARY TUMORS OF THE SKULL

When these are quite circumscribed they should be removed with the overlying skin and the underlying dura; at least two cm. of skin should be removed in every direction beyond the edge of the tumor.

Personally, we have never encountered any primary tumors of the skull in which it was possible to make a complete removal of the growth by this, or by any other method, but this does not make such a condition impossible,

and it is quite conceivable to obtain permanent results in cases coming under treatment reasonably early.

TUBERCULOSIS OF THE SKULL

This condition is not very uncommon and the results of surgical treatment are relatively favorable if two requirements are observed, viz., 1st, careful removal of every portion of the infected tissue, and, 2nd, careful control of the diet and hygiene of the patient after the operation.

In these cases one should never attempt the removal of the diseased tissue by means of the curette through the sinuses in the scalp, a method which had been practised unsuccessfully in every case that has come under our care to the present time. If a radical operation is not feasible for the time being, the patient should be placed under careful dietetic and hygienic treatment temporarily and the sinuses should be injected full of Beck's bismuth paste, consisting of one part of bismuth subnitrate and two parts of yellow vaseline. This should be repeated from one to three times per week, according to the progress of the case.

The discharge from the sinuses will become aseptic after a short time and complete healing may ensue, although our personal experience with the paste in this part of the body has not been sufficient to determine this with certainty.

Technique. It is highly important to make a large incision in order that every portion of the diseased bone may be exposed after the periosteum has been reflected, together with the skin flap. Beginning at the opening of any one of the sinuses of the skull, the outer table is chiseled away with a very sharp carpenter's chisel. In order to find all portions of the diseased bone it is important to observe the granulation tissue projecting from the cut surface of the bone after carefully sponging away the blood. Sharp, gnawing, bone forceps are very useful in this operation, but there is no instrument of as much value as the sharp carpenter's chisel and gouge.

After all of the sinuses have been followed and every portion of the infected tissue has been cut or curetted away so that there is at no point any granulation tissue to be found, the surface is dried and then saturated for ten minutes with 95 per cent. carbolic acid; then it is covered with strong alcohol until the white color caused by the carbolic acid has entirely disappeared, after which it is thoroughly covered with strong compound tincture of iodine. A little silkworm gut or rubber tissue drain is placed and the wound is sutured.

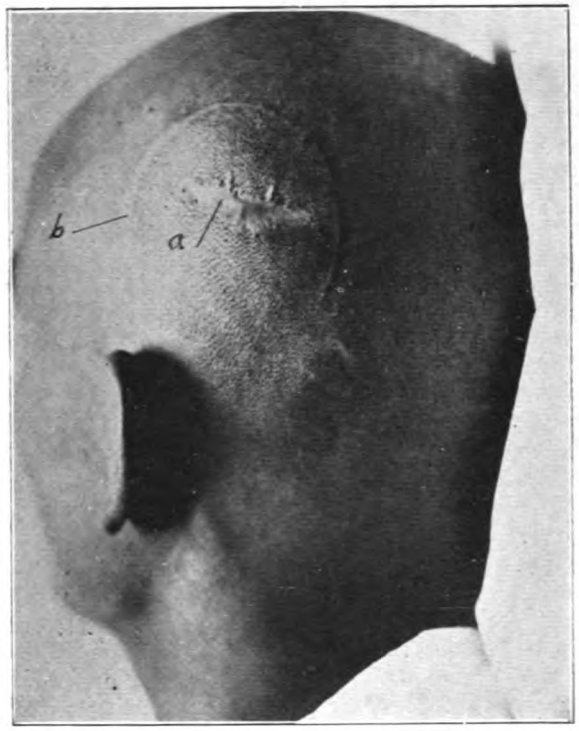
In the rare cases in which the overlying scalp has been destroyed by the disease a sufficient amount of the surrounding tissue is removed by the actual cautery to insure a complete removal of all of the diseased tissue and then the entire surface is covered with Thiersch skin grafts, after the bone surface has become covered with granulation tissue.

CLOSURE OF BONY DEFECTS IN THE SKULL

In case a considerable portion of the skull has been entirely removed, it may become desirable to close this defect in order to protect the patient against an accidental injury of the exposed portion of the brain. This becomes necessary only in cases in which the defect is very large, or in which it gives rise to some form of annoyance to the patient. The latter may feel a sense of insecurity or he may be annoyed by extreme heat or cold, or there may be a sensation of pain, or the constant pulsation of the area may give rise to a feeling of nervousness, or the irritation may occasion attacks of epilepsy. In

either case the defect may be closed by the insertion of a foreign substance between the scalp and the dura, such as a thin plate of celluloid, which may be boiled and cut the exact shape of the defect, with a sufficient margin to hold the plate when inserted underneath the rim of the defect in the skull. If such a plate is implanted aseptically it will remain for an indefinite period of time without giving rise to any annoyance. We have used such plates in a number of cases with perfect satisfaction. It must be remembered, however, that in cases of epilepsy the number of cures from the use of such a plate is relatively very small.

An autoplastic bony closure may be accomplished by cutting an oval flap of the scalp directly along the side of the defect with a pedicle sufficient to



Case of Traumatic Epilepsy Due to Old Organized Blood Clot. (a) Original Scar, and (b) Operative Trephine Scar.

supply circulation; then cutting a second flap of the same shape directly covering the defect and having its pedicle in the opposite direction from the one first made. The second flap is dissected loose, leaving the dura in place. The latter is then loosened from its attachment to the rim of the opening and with a thin, broad chisel a thin layer of the skull underlying the first flap is chiseled loose and left in contact with the flap. The latter is then transplanted over the defect in the skull and sutured in place, and the second flap is then sutured into the space from which the first flap has been removed. In this manner all portions of the scalp will remain covered with hair and the bone carried with the first flap will effectually close the defect in the skull.

This operation has usually been performed by removing the scalp from the surface of the defect and transplanting a flap from a neighboring portion of the skull and then covering the defect with skin-grafts, but the method which has just been described is very much more satisfactory, as it does not leave a portion of the scalp without its hairy covering.

For a number of years we have cut away the cicatricial tissue covering the brain at the point of injury. To cover the defect we have then cut a piece out of the fascia lata of exactly the right size and containing a layer of fat 2 mm. in thickness. This we have sutured so as to place the fat in contact with the brain by means of six or eight fine catgut sutures. In most cases this will furnish a good protection for the underlying brain, even if no portion of the skull has been transplanted. We have found it especially worth while to give patients of this group very distinct written instructions as to their diet and hygiene following this operation, to be continued constantly throughout their lives. They are instructed to avoid all excesses, especially as regards eating, work and excitement, to reduce the use of table salt to a minimum, and to substitute bromide of soda for the salt used at table on eggs and other food requiring some seasoning. They are also advised to use a meat-free diet almost exclusively, and not to expose themselves to extreme heat.

CEREBRAL LOCALIZATION

In order to intelligently approach surgical conditions within the cavity of the skull, affecting portions of the brain, it is absolutely necessary to have a clear conception of cerebral localization.

We have personally always depended upon some one of our colleagues whose opinion, from a neurological standpoint, was so vastly superior to our own that we have never felt called upon to rest upon our own judgment in the matter of locating cerebral conditions independently.

We have, however, always confirmed these diagnoses before opening the skull, simply for the purpose of having a reasonable basis upon which to share the responsibility.

For practical purposes it seems best to obtain a mental picture of the entire brain, and to associate the various areas with their functions, and then to transfer these areas to the surface of the skull.

The accompanying drawings by Prof. Chas. K. Mills, are exceedingly simple and clear, and we have found them most useful in our own clinical work.

There are certain general facts concerning cerebral localization which must always be borne in mind in diagnosing brain lesions, which are, however, so well known that it is scarcely proper to mention them in this place. We refer particularly to the fact that, with the exception of certain muscles like the orbiculares oculi, those of mastication, the larynx, the pharynx, etc., the muscles of the body are controlled by the motor areas of the opposite cerebral hemisphere. There may, however, be a tumor, abscess, or blood clot, in one hemisphere, exerting a sufficient amount of pressure transversely upon the other side to cause symptoms originating in the opposite hemisphere, so that symptoms of paralysis in these rare cases will be found on the side on which the brain lesion exists.

It is further important to remember that these areas of localization are not definitely circumscribed, but that they overlap each other.

Cerebellar localization. The research work of Mills and Weisenborg has done much to aid in cerebellar localization. The cerebellum serves as a center

of coördination for the motor activity of the cerebrum. Centers have been located so that in addition to usual signs of brain tumors, we have incoördi-

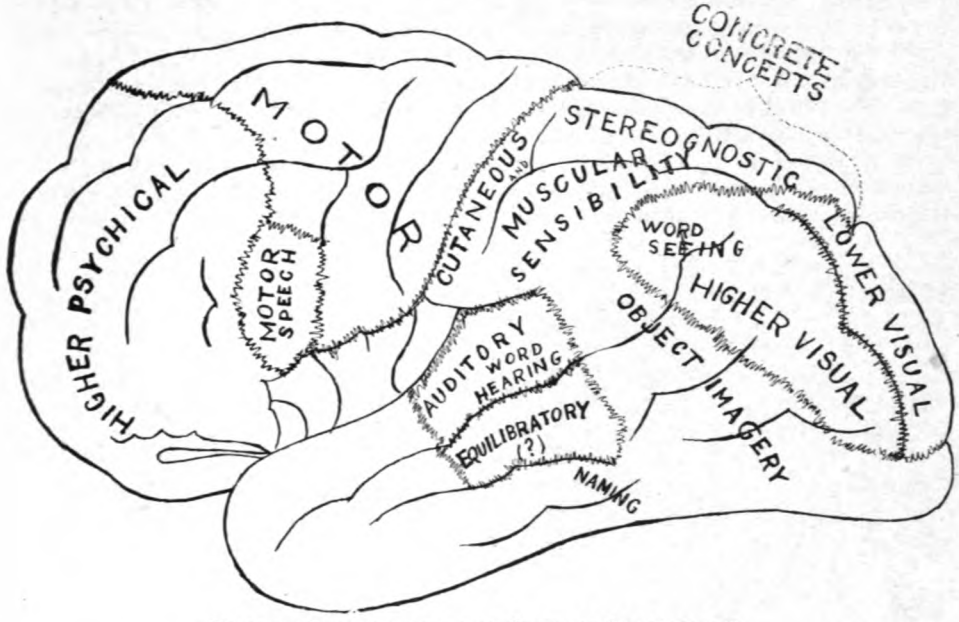


Diagram Showing Areas of Cerebral Localization.

nation of movements of the hand, leg, pelvic, or shoulder girdle. By means of the Barany tests, in the hands of an expert, lesions can be located with great

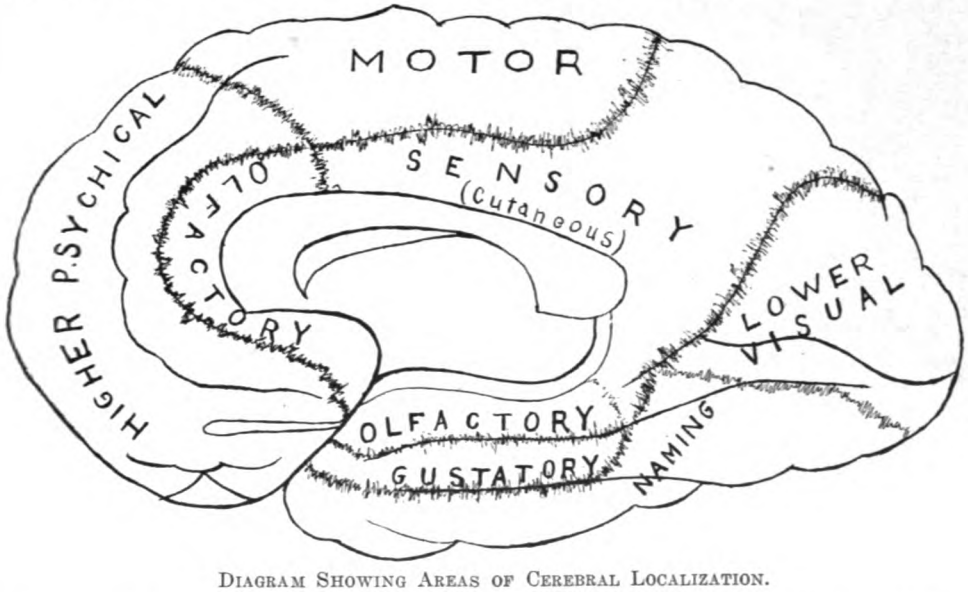
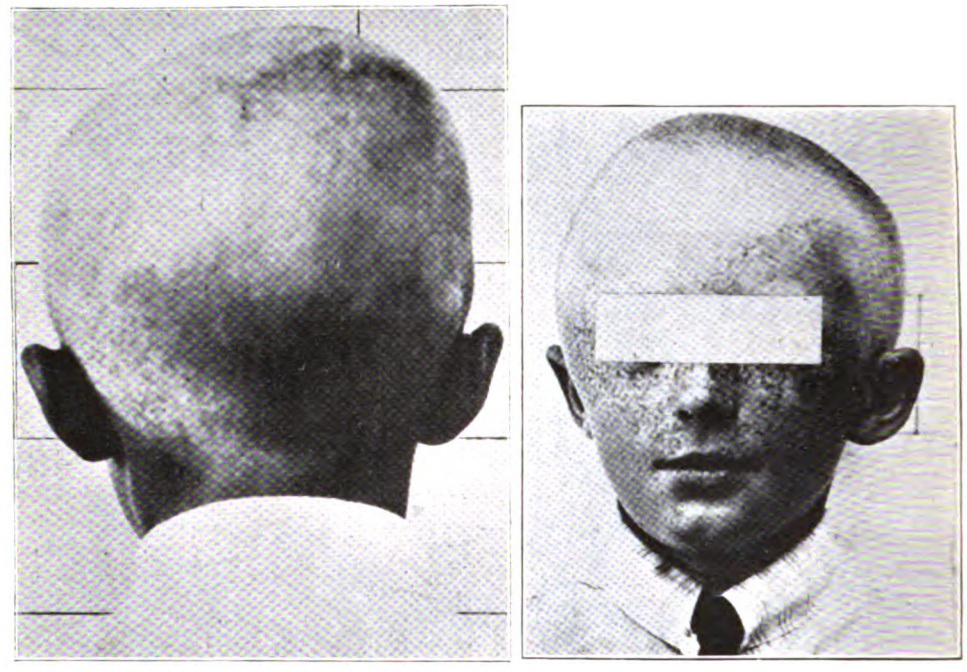


Diagram Showing Areas of Cerebral Localization.

accuracy. Adiadokokinesis, gait, and station also help in locating cerebellar lesions.

TREPHINING FOR THE CURE OF EPILEPSY

In cases in which epilepsy follows fracture of the skull and in which it is possible to determine positively from local symptoms that there is a definite point in the cerebrum which is being irritated by some condition resulting from the fracture, it may be proper to remove a portion of the skull overlying the area which has been determined and to remove any irritating substance it may be possible to discover. Occasionally an exostosis has developed from the line of fracture in the form of a sharp spicule of bone, or a fragment may have been displaced at the time of the original injury and may extend into the substance of the brain, or a small cyst may have formed on the under surface of the dura or the latter may be markedly thickened, or there may be a consider-



HYDROCEPHALUS WITH JACKSONIAN TYPE OF EPILEPSY IN A 10-YEAR-OLD BOY. RELIEVED BY DECOMPRESSION.

able amount of cicatricial tissue in the brain substance, resulting from the healing of a tear.

All of these may readily be relieved by excision, but unfortunately this does not result in a cure in many of the cases of epilepsy which are unquestionably traumatic in origin.

The trephining should be made over the site of the previous trauma, and the bone removed during the operation should be discarded. There seems to be less likelihood of having a recurrence than when the bone has been replaced. If it has been necessary to excise a portion of the dura, this can be replaced by putting a piece of fat or fascia lata between the brain and scalp where the dura has been removed.

Importance of after-treatment. In the after-treatment of these cases that have been treated surgically it is important to insist upon good hygiene and dietetic care for a long period of time. It is also well to give these patients as nearly as possible a salt-free diet and to have them use a very small amount

of bromide of soda, in place of table salt, on their food. All excitement, overwork, exposure to heat, and every other form of physical and mental irritation should be avoided. The use of thyroid extract may be tried by giving from three to four doses daily of three to five grains.

We have used this form of treatment in many cases, and although its results have been disappointing time and again, still there have been a sufficient number in which the results were satisfactory to make the effort worth while.

This is true especially where we have been able to direct the diet and hygiene of the patient subsequent to the operation.

Many of these patients have acquired careless or erratic habits of life, and especially unfavorable habits of diet, both as regards time of eating and quantity and character of food. We have observed patients who remained perfectly well for months or years who had a recurrence of an epileptic seizure after eating an unreasonable amount, or after eating a large meal when exhausted after a day's labor. One of these remained well until he worked beyond his strength for a number of days in the hay field, after having been well for two years following an operation for the relief of a depressed fracture of the skull. This case had suffered from epilepsy for several years previous to the operation.

It seems clear that although the local irritation in the cortex may have been relieved by the operation, any one of a number of correlating influences affecting the patient's general condition may be the cause of a recurrence, hence the wisdom of careful control of the patient after operation.

IDIOPATHIC EPILEPSY

Since Kocher advanced the theory that an increased intracranial pressure was the important etiological factor in idiopathic epilepsy there has been some hope of giving relief surgically to some of these unfortunate cases. During the past few years quite a number of surgeons have made some form of a decompression operation in these cases with a varying degree of success.

Kocher makes a decompression in the right fronto-parietal region by first making a large flap of scalp with pedicle downwards, then excising a large area of bone in the fronto-parietal region. The dura is carefully excised, the area removed being a little smaller than the opening made in the skull. The scalp flap is then replaced and sutured.

During the past two years the authors, in addition to making a decompression operation, have followed the method of Kirscher of replacing the excised dura by a flap of fascia lata. The technique is as follows: A large scalp flap is made right over fronto-parietal region with its base downwards. The skull is opened and the bone removed from the fronto-parietal region low down. The decompression should be made as near the base of the brain as possible, so as to keep away from the motor areas. The dura is excised from this entire area, leaving about one cm. of dura inside of the skull opening.

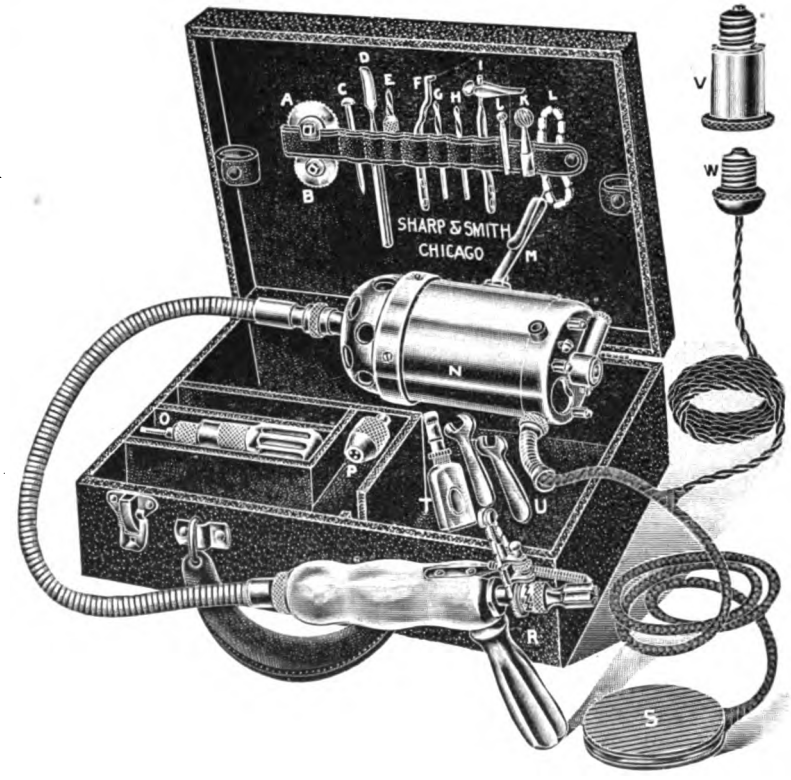
A flap of fascia lata with a little subcutaneous fat, the size of the bony defect, is removed from the patient's thigh, and placed, fat side downwards, over the dural defect. This fascia overlaps the dura all around about one cm., to which it is attached by placing a few cat-gut sutures. The scalp flap is then replaced and sutured. Too short a time has elapsed to give any final conclusion, but so far the results by this method have been quite satisfactory. The same after-treatment should be carried out in these cases, as previously described in connection with operation for traumatic epilepsy.

TUMORS OF THE BRAIN

The removal of a fibroma, gumma, or cysts from the brain is frequently followed by permanent recovery of the patient, and as it is usually impossible to

make a differential diagnosis between these and malignant growths an attempt at their removal is of course justifiable, because the consequent pressure from benign growths will result seriously to the patient, even if it does not shortly destroy him. Therefore the patient who is suffering from a non-malignant tumor has everything to gain from operative treatment, while the one who suffers from the presence of a malignant growth has nothing to lose and, as will be presently indicated in the discussion of the decompression operation, even this class of patients has much to gain.

Cushing, Mills, Krause and Horsley have demonstrated the possibility of



HOGLUND'S ELECTRIC ROTARY CHAIN-SAW.

exact localization so constantly and so many times that one can usually be positive concerning the location of cerebral tumors.

Experience and special training. At this point it may be well to state that it is not proper to undertake this operation unless a surgeon has had experience in the capacity of assistant to a skillful and careful master. It is quite different from operating for cerebral pressure, due to the presence of a blood-clot caused by hemorrhage from a torn vessel, which is really an emergency operation that cannot wait for a surgeon with special training.

Technique. Many of these patients lack resistance and consequently the surgeon with the greatest experience and skill, and the best judgment, is none too well-equipped for performing a successful operation. In many, it is best to make the skin and bone flap at the first operation, and then, a few days

later, when the patient has recovered from the shock of this step, to complete the work. In the meantime a piece of aseptic gauze is placed underneath the flap and the latter is held in place by means of a few sutures and the entire area covered with an aseptic dressing.

With some experience it is possible to determine which cases should be treated in one and which in two stages.

The trephining may be accomplished by means of an ordinary trephine and the bone flap cut out by a DeVilbiss forceps, as previously described, or by using one of the various electrical devices now in use, such as Hoglund's electrically propelled rotary chain-saw and automatic trephine, which we have found to be very satisfactory.

The rotary chain-saw is so arranged that it will cut a circular flap as small as two inches in diameter. The trephine is connected to the driving shaft by means of an automatic clutch, so that when the trephine is almost through the bone the clutch will automatically disengage itself and, rotating the trephine, leave a thin, transparent bone plate from the vitreous part of the skull. This absolutely prevents injury to the dura mater when trephining. The chain-saw is now introduced through the trephine opening and a large or small circular piece of bone is cut as desired. The bone edge can be made either straight or bevelled by tilting the instrument to any angle desired.

In brain operations hemorrhage is one of the most troublesome features. Only a few of the bleeding vessels can be controlled with hemostatic forceps and ligatures.

The hemorrhage from the scalp can be controlled by encircling the skull with a tight rubber band approximately along Reid's base line. This constrictor must be very tight, or it will increase the venous oozing, making that more troublesome than without anything.

Crile has recently devised special needle clamps to be used in controlling this hemorrhage, which clamps are applied by means of a special forcep for that purpose. The clamps are actuated by powerful springs and control the hemorrhage perfectly.

If hemorrhage from the edge of the skull is troublesome it may be controlled by crushing the edges of the bases with heavy bone forceps, or by using Horsley's bone wax, the composition of which is: beeswax, 7 parts; almond oil, 1 part; salicylic acid, 1 part. A little of this wax pressed against the bleeding diploë will readily control hemorrhage from this source.

Most of the hemorrhage from the brain must be controlled with gauze pads wrung out of hot, normal salt solution. Even very severe oozing of blood from the cut brain surface can usually be checked by holding one of these pads in contact with the bleeding surface for a period of five minutes. If this does not suffice in giving a sufficient amount of freedom from bleeding, the head of the table should be elevated in order to place the body at an angle of from forty to sixty degrees with the horizontal plane. If this does not answer, the wound should be tamponed with sterile gauze and the operation completed after an interval of several days. Frequently there will be severe bleeding from a small pial vessel. Very often applying to the bleeding area a small piece of muscle cut from the edge of the wound will stop bleeding when everything else fails.

After the tumor or gumma has been enucleated the cavity should be tamponed with a gauze pad wrung out of hot, normal salt solution, and this should be left in place for at least five minutes. If hemorrhage is seen to have ceased when the tampon is removed, the dura and skin-flaps should be closed, with the exception of one angle. If hemorrhage has not ceased the cavity should again be tamponed with an aseptic gauze strip and one strand should be passed out

of the angle of the wound, which is to be closed as above. A piece of gutta percha tissue should be placed about the part of the gauze passing through the dura and the scalp in order to facilitate its removal a few days later.

DECOMPRESSION OPERATION

In many cases in which a tumor cannot be removed and in which the patient suffers from pressure symptoms, such as headache, dizziness, nausea, or eye symptoms, as indicated by impaired vision and by the presence of choked disk on ophthalmoscopic examination, he may be greatly benefited by the removal of a large portion of the skull on one or both sides.

A flap is made preferably over the temporal and parietal region low down near the base of the skull. It should include the scalp and the skull together with the dura. If an exploration seems indicated, the dura is not primarily removed, but a crucial incision is made in the dura, which is later closed with catgut sutures, if a removable tumor is found, but otherwise it is cut away at once. The bone flap is removed entirely and the skin flap is closed, with the exception of a space of about one cm. at one angle. We have repeatedly observed a marked subjective improvement in the vision in these instances and a disappearance of all of the other symptoms due to cerebral pressure.

Where the object is that of decompression alone, Cushing does a temporal decompression, a right in right handed people, and a left in left handed people. In so doing, danger of injuring the speech center is obviated. A curved incision is made extending from near the sagittal suture down to the zygomea with the convexity backward, over the squamous portion of the temporal bone. The skin is raised, the fascia and muscle split in the course of the fibers, and the periosteum removed to one side. It is an easy matter to make a trephine opening and, with a rongeur, cut away the bone. The dura is incised with a cruciate incision. Then the muscle, fascia and skin are sutured separately. This will allow the brain to bulge and relieve the pressure. The muscle and fascia are a strong support and give the hernia a strong wall.

In most cases the patients have remained comfortable after operation until they have suddenly died from hemorrhage or from a perforation of a lateral ventricle, but in each one the patient and his friends have agreed with us in the supposition that the operation had been of marked benefit to the sufferer.

In cases in which it is plain from the start that nothing can be done except a decompression operation, it is perfectly proper that this be undertaken by a surgeon of ordinary skill and without especial experience, but this is never proper in cases in which a surgeon with greater skill might be justified in removing the tumor.

ABSCESS OF THE BRAIN

What has been said with regard to tumors of the brain, so far as localization and approach through the skull are concerned, may also be applied to cerebral abscess. In these cases there is, however, usually a history of suppuration, most commonly in the middle ear and mastoid cells, and occasionally in the cavities connected with the nose.

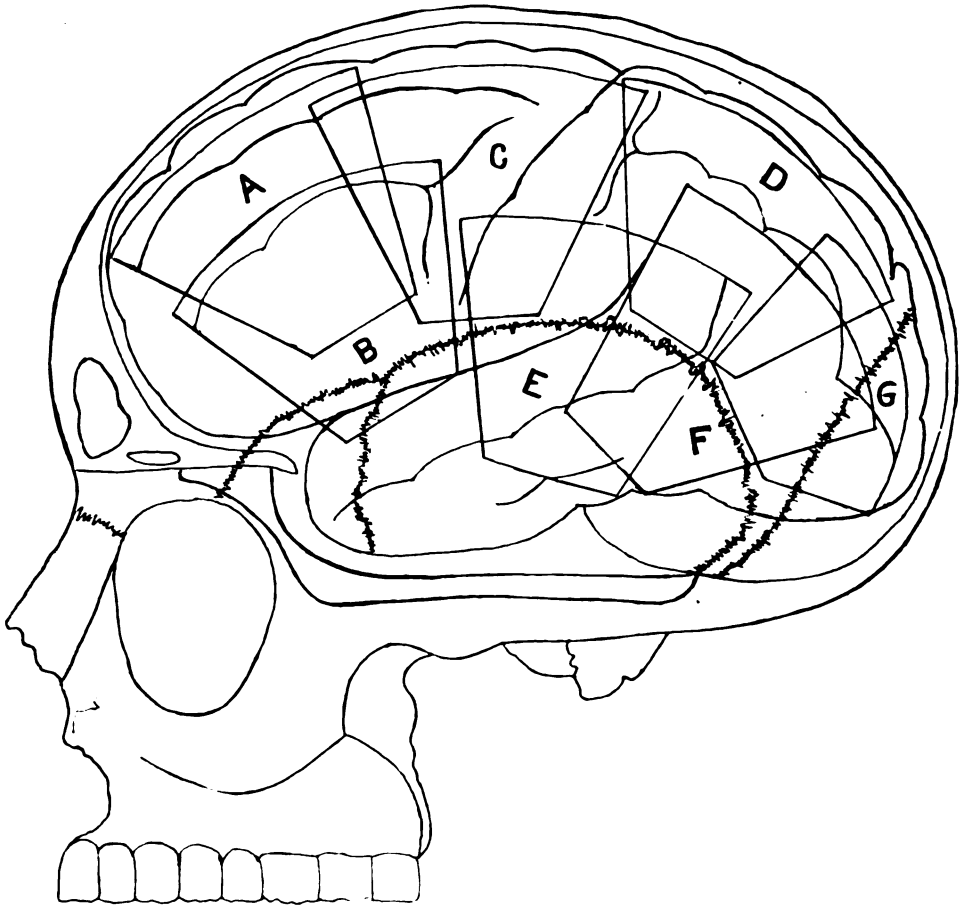
Nausea is usually one of the prominent symptoms and there is often, but not always, a rise in temperature at some period during the day.

Due to the scarcity of lymphatics in the brain, an abscess located there may be unaccompanied by either fever or leucocytosis.

After exposing the dura by reflecting a bone flap there may be an absence of pulsation and the dura may be edematous, showing that the abscess is

superficial. In this event a simple incision, with the insertion of a soft rubber drainage tube, will suffice.

Should the abscess not be superficial the deep tissues may be explored by the use of an exploring needle, with a closed, moderately-sharp end and a fair-sized hole in the side near the end. It should carry an obturator in order to prevent the brain tissue from clogging the canula. From time to time this should be removed and an aspirating syringe attached; if pus escapes an incision should be made along the side of the exploring trocar and a soft-



Cranial Areas for Osteoplastic Operations.

rubber drainage tube inserted. A notch should be cut in the bone flap sufficiently large to prevent compression of the tube, which should be passed out at this point and the wound closed, sufficient space being left for satisfactory drainage. Irrigation should not be employed. The drainage tube should be left in place until the discharge of pus has ceased.

It should be borne in mind at this point that by far the most important duty of the surgeon is to prevent the formation of cerebral abscesses by early radical treatment of suppuration wherever it may occur, but especially suppuration of the middle ear and of the mastoid cells.

RESECTION OF THE MASTOID CELLS

Patients suffering from infection of the mastoid process usually give a preliminary history of some infectious disease affecting the tonsils. This is followed by an infection of the cavity of the middle ear. The abscess of the middle ear may have been drained spontaneously by a perforation of the drum, or the latter may have been incised, but there is usually a history of recurrence of this infection or a continuous infection indicated by the presence of interrupted or continuous discharge from the ear. Following this pain appears behind the ear in the region of the mastoid process. Frequently this pain subsides when the discharge reappears, indicating that drainage has been established from the mastoid process through the middle ear. In other cases the pain steadily increases and is presently followed by the occurrence of edema over the region of the mastoid process, which may extend downwards upon the neck along the course of the deep jugular vein. In rare instances there may be fluctuation in the region of the mastoid process, or even perforation of the abscess, but usually the resistance of the periosteum covering this process is sufficient to prevent these evidences from appearing.

Still later the patient may suffer from diffuse headaches extending over a more or less extensive region, usually radiating from the site of the infected process. Still later the patient may become comatose, or nausea and vomiting may appear, which may be followed sooner or later by coma and death. The explanation of the condition described lies in the fact that the infection has extended from the cavity of the middle ear into the mastoid cells. It has then progressed outward to the periosteum, or through this, or it has extended inward underneath the dura and has caused a more or less diffuse meningitis, sometimes accompanied by a subdural abscess, or it may have extended into the brain—giving rise to a cerebral abscess. These patients are usually seen by the practitioner before the infection has advanced beyond the mastoid cells, and it is at this time that the greatest amount of benefit may come from surgical intervention. At this time the operation is safe, it can be performed by any surgeon with ordinary skill, and the patient is not likely to suffer secondarily as a result. It is quite different if the operation be postponed until there has been a considerable extension of the infection. In such event it is scarcely proper for any one who has not had extensive experience in brain surgery to operate upon these patients, and even with the greatest skill the proportion of recoveries is but slight. In cases operated at the proper time, that is, during the early part of the infection, the drainage which can easily be established will prevent the further infection of the deeper structures, and consequently will make a more extensive operation unnecessary.

It would seem that the presence of pain, together with even a slight amount of edema in the region of the mastoid process, the pain being increased upon pressure, and in any case in which there is a history of previous infection of the middle ear, would be a distinct indication for an operation.

Technique. A sufficient amount of hair should be shaved off in the vicinity of the mastoid process to prevent annoyance in applying the dressings later on and to prevent the hair from interfering with the progress of the operation. A vertical incision is then made directly behind the ear, one and one-half inches in length, whose center is at a point one-fourth of an inch behind and exactly on a level with the upper margin of the external auditory meatus. This incision should extend down through all the tissues to the bone. The periosteum is carefully reflected and in this manner the mastoid process is exposed.

If the points which have just been mentioned are borne in mind, the operation may be performed with safety by any one, the opening into the mastoid cells being made by means of an ordinary carpenter's gouge about one-half inch in diameter.

The dangers of the operation are in opening the meninges above, or invading the sinus behind, but if the operator makes his initial opening in the mastoid process at a point on a level with the upper margin of the external auditory meatus and one-fourth of an inch behind the posterior margin, these dangers will be entirely avoided. After the mastoid cells have once been entered the opening can easily be enlarged by chiseling in every direction from this central point. The mastoid cells will be found to contain pus in various quantities from a few drops to one-half a drachm or more. This is carefully sponged away and the external avenue enlarged until it is as large in every direction as the greatest diameter of the underlying cavity, so that the cavity which is left will be conical in shape, with the base of the cone directed upward. It is exceedingly important that no cells be overlooked in the tip of the mastoid process and in the region of the supra mastoid crest. A suppurating cell can prolong convalescence several weeks. Care should be taken not to injure the branch of the facial nerve extending along the edge of the external auditory meatus, but this can be easily done in most instances by simply bearing in mind the anatomical position of this nerve and working away from it with the chisel, instead of toward it. One must, however, bear in mind the fact that the nerve is very delicate and that it may be abnormally located, so that, even if the greatest care is exercised, an injury to this nerve may occur with its resulting paralysis. The cavity after being thoroughly cleansed, is loosely tamponed with gauze and a dressing applied over it.

The dressing should be renewed at first every day, and later less frequently, the opening in the mastoid being permitted to heal from the bottom by granulation. In advanced cases, and in those in which the infection has existed for a sufficient time to insure the involvement of surrounding tissues, a more extensive operation is indicated, but this should be performed only by those experienced in surgery upon the skull, as the dangers of causing permanent injury are much greater, and the necessity of the operation is not so urgent as in acute mastoiditis; consequently such operation may safely be postponed until the proper preparation can be made. The conditions are, therefore, quite opposite in acute mastoiditis; the operation being simple, safe and strongly indicated at once, while postponement is connected with great danger. In chronic cases the operation is complicated, difficult and dangerous, while postponement is relatively safe.

MASTOID OPERATION IN CHRONIC CASES

It is difficult to describe this operation so that it can be performed safely by one who has neither accomplished it upon the cadaver nor has seen it done upon the living subject, and we believe, therefore, that this operation is not justifiable unless the surgeon has performed it upon the cadaver.

The incision is the same as in the operation just described; the periosteum is then stripped away toward the external auditory meatus and a blunt periosteotome is passed down between the bony canal of the external auditory meatus and the skin lining this canal, so that the latter is loosened down to the tympanum. The mastoid antrum is then opened, as described in the former operation, and the lower layer of the posterior wall of the bony portion of the external auditory canal is removed with a chisel, so that the external auditory meatus and the cavity in the mastoid form a continuous

conical opening. The cavity of the middle ear is then opened and the hammer and anvil are removed by means of forceps. Great care must, of course, be exercised to protect the branch of the facial nerve which passes through the bony wall of the inner half of the antral passage obliquely from without inwards as it passes the inner wall and roof of the tympanum. The skin lining the external auditory meatus is then split longitudinally and spread out over the surface of the newly-formed cavity for the purpose of lining this, thus increasing the size of the external auditory meatus greatly. It is held in place by means of a tampon of iodoform gauze.

Use of Beck's bismuth paste. During the past few years we have found that cases in which the infection extends down the Eustachian tube at the time of operation, causing a reinfection of the wound and a consequent retardation in healing, excellent results may be obtained from dressing the cavity with Beck's bismuth paste, consisting of one part of bismuth subnitrate and two parts of yellow vaseline, applied daily at first and less frequently later on.

Of course, by invariably removing the infected tonsils and the adenoids, which are located about the osteum of the Eustachian tube, conditions are established which are favorable for the spontaneous healing of any suppurating surfaces which may exist in this tube. We have never injected Beck's bismuth paste directly into the Eustachian tube, but it is claimed that this is a safe and beneficial procedure in these cases.

INFECTIVE SINUS THROMBOSIS

This condition is usually secondary to infection about the ear, scalp, nose, throat, or orbit; the vast majority of cases, however, occur as a complication of middle-ear disease.

The symptoms are those of septicemia or pyemia, with frequent chills and a very irregular temperature, ranging from 100° to 105°.

The lateral sinus is the one most frequently involved. The history is usually one of a middle-ear infection, followed by chills, irregular high temperature, with pain, tenderness and edema along the line of the sinus and down over the mastoid and along the jugular vein, if it is involved.

In thrombosis of the cavernous sinus exophthalmus develops, together with edema about the orbit and eyelids. Choked disc is also present and there is apt to be paralysis of the third, fourth and ophthalmic division of the fifth and sixth cranial nerves.

Treatment. In thrombosis due to middle-ear disease, the mastoid should be trephined as previously described, and the lateral sinus exposed and examined to determine the presence of a thrombus. The jugular vein should then be ligated to prevent further dissemination of the thrombus downwards. The lateral sinus is now opened, and if the thrombus has extended down into the jugular vein, the portion of the vein above the ligature should be excised. The sinus can now be irrigated through into the neck, after which both ends should be tamponed with gauze. The prognosis is bad, the mortality being at least fifty per cent.

REMOVAL OF THE GASSERIAN GANGLION

During the past few years this operation has been performed many times by many surgeons, so that it is now a thoroughly established procedure. Cushing and Frazier and Krause have discussed the special methods which they have applied in a very large number during this time, and for those who

are particularly interested in this operation it is well to read the writings of these authors.

Before performing this operation it is most important to do it upon the cadaver, remembering well, however, that the chief difficulty in the operation upon the living subject comes from the fact that there is always a certain amount of blood present to obscure the field, and that for this reason the simple directions which follow are often quite difficult to carry out.

Operative precautions and technique. Preparatory to this operation, provision should be made against the occurrence of an injury to the conjunctiva, from the fact that the operation is accompanied by paralysis of this portion which prevents the eyelids from protecting the conjunctiva against injury. The conjunctiva is therefore protected temporarily by closing the eyelids by the application of a few fine silk sutures. These are removed at the end of from one to two weeks, and then the eye is protected mechanically by the use of a properly adjusted shield. The next step consists in providing for a bloodless operation. This can be accomplished by taking great care in elevating the dura. Usually a blunt instrument is used to loosen the dura, and in a majority of the cases, hemorrhage from the middle meningeal occurs. A method we have found quite useful is, first, to loosen the dura from the bone with a blunt elevator; then take a thin piece of gauze and force this gently between the dura and the bone along the entire base. This makes a gentle, uniform pressure along the entire base. By removing the gauze often, one can see just how things have progressed. By continuing this method the dura may be readily elevated, the middle meningeal exposed and not torn.

If the middle meningeal is torn, a small wooden peg, sterilized, held on a forceps, can be forced into the foramin, and the hemorrhage controlled.

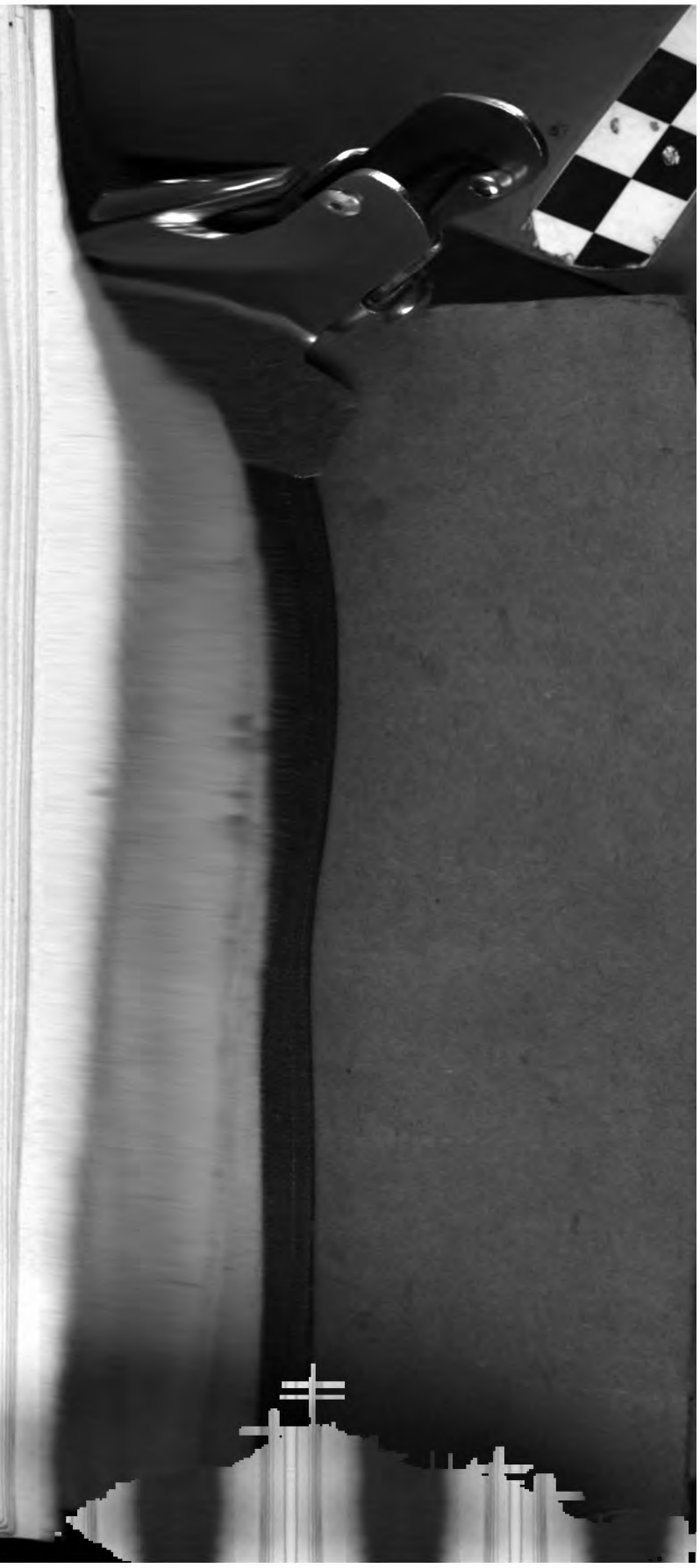
A curved incision is made with the convexity backward and a small flap thrown forward. Along the base of the flap another curved incision with the convexity forward is made, and the flap of temporal fascia and muscle thrown backward. The skull is exposed, and bleeding points caught. The incision is so planned that it remains wholly within the hair line. When the hair has grown again, the incision is not visible.

With an electrically driven burr, the skull is trephined. A small rongeur is used to enlarge the opening. This takes only a few minutes. Any bleeding from the bone is controlled by means of Horsley's bone wax.

The dura is carefully elevated by a gauze dissection until the third and second branches of the fifth nerve are seen. By following these back, the ganglion can be found. The ganglion lies in a sheathe of the dura, and, by incising the dura, it can be exposed. With a small hook the sensory branch is caught and cut with a small sharp knife. There must be no pulling with the hook, for hemorrhage from the cavernous sinus may result. Care must be taken to avoid the small motor branch of the fifth nerve which lies just behind the sensory branch. If care has been exercised the field will be dry. The brain is allowed to fall back, and the flaps are sutured in place. Fine interrupted chromic sutures are used for the fascia and muscle, and horsehair or silk worm gut for the skin.

We believe that the operation is greatly aided by certain factors. First, the patient is given ¼ gr. of morphine and $\frac{1}{100}$ gr. of atropine one-half hour before operation. Second, the patient is fully anesthetized in the dorsal position, and the head is elevated 45°. The elevation of the head produces an anemia of the brain. This permits greater retraction of the brain, with a better field of operation. The bleeding is much less severe.

This method of administering the anesthetic necessitates no administration of ether during the operation, consequently shock is markedly reduced.



It may be well to caution the surgeon against the careless use of the retractor in lifting the cerebrum. A spatula-shaped retractor is usually held by an assistant for this purpose, and unless he has been very carefully cautioned there is danger of his traumatizing the brain tissue during the performance of the operation. This part of the work should be given to a thoroughly competent assistant.

Shock due to avoidable traumatism is undoubtedly the cause of more deaths during or following this operation than any other one condition, which accounts for the difference in mortality at the hands of otherwise equally competent surgeons.

RESECTION OF PORTIONS OF THE TRIGEMINAL NERVE FOR THE RELIEF OF NEURALGIA

During the early portion of an attack of trifacial neuralgia usually only one of the principal branches is involved. The most common one, in our experience, has been the submaxillary branch.

Internal treatment and dietary. In all cases of trifacial neuralgia, without regard to the portion of the nerve involved, it is wise always to subject the patient first to carefully directed internal treatment. In a considerable proportion of these cases the affection seems to be due to an auto-toxemia from the alimentary tract. In these cases the daily use of from two to four ounces of castor oil, given in the foam of beer, will result in a permanent cure in at least one-half of all instances. At first the oil will act as a violent cathartic, but this property soon disappears, and after a few weeks the patient may continue to take this amount of castor oil daily without any disturbance of the bowels.

In the meantime these patients should be cautioned against the use of food which is likely to cause undue fermentation. Sugar should be prohibited entirely. Starchy foods should be limited, and acids used very sparingly. In case this and other forms of treatment fail to give relief, the excision of a portion of the affected nerve is indicated. During the past few years a number of surgeons have advised the excision of the Gasserian ganglion for the relief of all facial neuralgias without regard to the branch involved. This seems, however, scarcely justifiable, because in many cases in which only a portion of the affected branch has been excised the patient has recovered completely and permanently; and if a complete recovery does not occur, it is still possible to perform a radical operation.

Injection of alcohol. During the past few years we have obtained excellent results in many cases by injecting 1 per cent. cocain in 85 per cent. alcohol directly into the nerve sheath, or as near the nerve as possible. This should be repeated once a week until the pain ceases to return. Sometimes one injection will suffice, but more frequently it is necessary to repeat several times. It may be necessary to inject as often as five or even ten times. In cases relieved by this method one can usually count on freedom from pain for at least one year, when the treatment may be repeated sometimes with equally satisfactory results.

In the meantime the patient should be under strict supervision regarding the state of his general health. His diet and hygiene should be carefully controlled. The food should be consistently chosen, thoroughly masticated, and absorption of products of decomposition from the contents of the alimentary canal should be prevented. The urine should be examined at regular intervals, especially for the presence of indican.

The condition of the patient's teeth should be made as nearly perfect as

possible, and all other influences affecting his general health should be carefully controlled.

Technique. In order to succeed it is well to have a human skull at hand at the time of operation, inasmuch as this gives the operator a better idea of distance and direction than he can have otherwise.

It is also advisable to inject methyl-blue experimentally in the cadaver in order to gain accuracy in actually reaching the nerve.

Especial needles 10 cm. long, 1 mm. or 1½ mm. in diameter, containing a stylet, can be obtained from the instrument makers, to be used in this operation, but different surgeons prefer needles of different thickness and style, the important point being to secure a needle that will penetrate the deep tissues in the exact direction intended by the operator. If the injection fails to give relief, and if the area supplied by the branch injected is not analgesic after the mixture has been forced into the tissues, it is certain the nerve has not been reached. In this event it is best to force the needle in a little farther and to inject 2 cc. more of the fluid. If this again fails, the needle should be withdrawn slightly, and more of the fluid should be injected at various points. If this, in turn, is ineffectual, it is best to withdraw the needle and to bear in mind the direction of its employment and then to repeat the injection in a slightly different direction after a few days. It is not wise to risk tearing the tissues by pushing the needle in different directions at one sitting.

Injection of the inferior branch of the fifth nerve. The needle is inserted at the lower border of the zygoma, one inch in front of its descending root, which is near the anterior long border of the external auditory meatus.

The needle is directed a little backward and slightly upward, so as to hug the base of the skull, and it should reach the nerve at its exit from the foramen ovale at a depth of 4 cm.

The middle branch. Draw a line from the posterior border of the ascending process of the malar bone to the lower border of the zygoma. Insert the needle .5 cm. posterior to this point, directed so that it would reach the foramen rotundum in the skull you have for comparison. The nerve is reached at a depth of 5 cm.

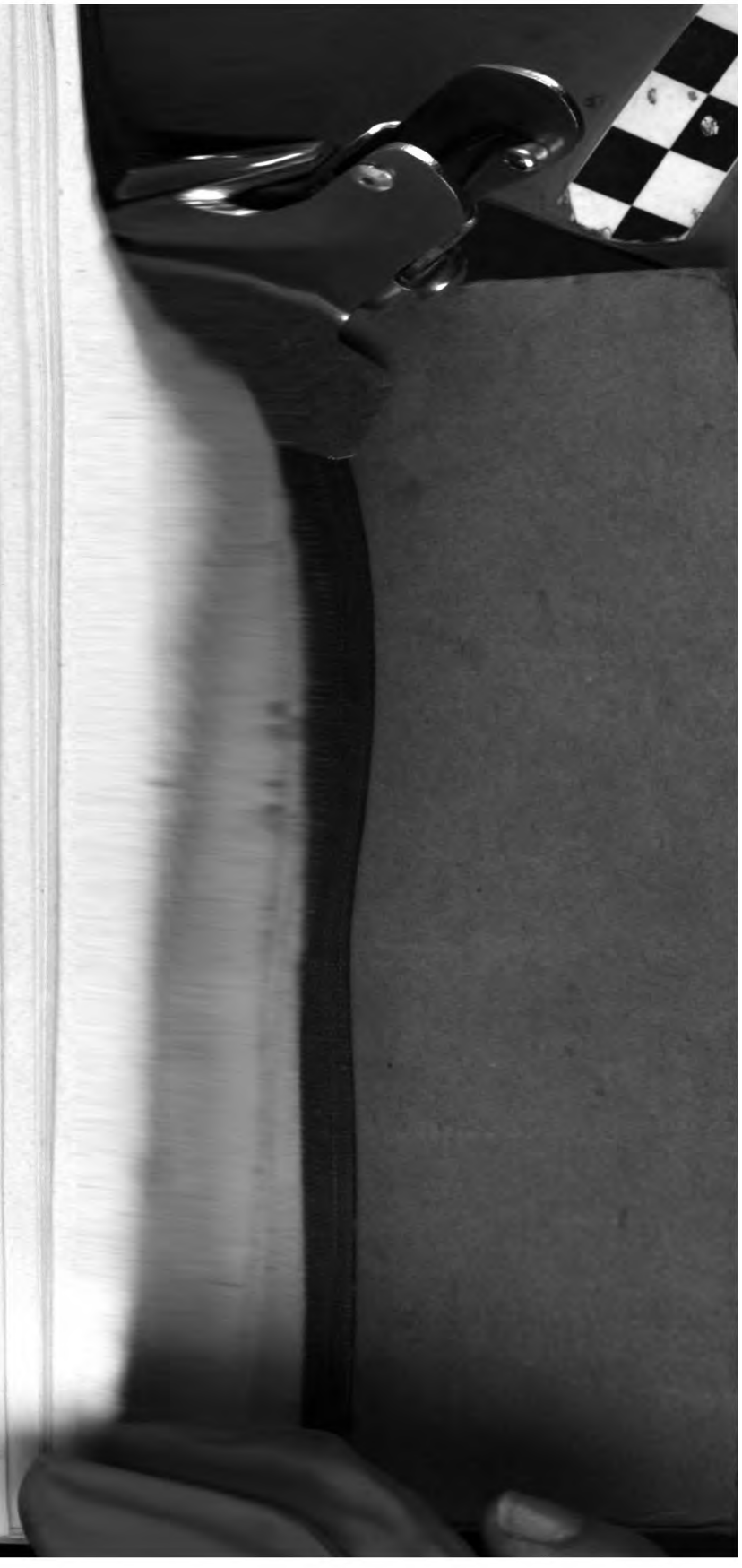
The supraorbital branch. Inject from the supraorbital notch or foramen.

Osmic acid injections. This method has been almost entirely discarded since the introduction of the injection of alcohol. It differed from the latter in the fact that the diseased nerve was laid bare at the most available point and a few drops of osmic acid injected directly into it. The results were no better than those now secured from the injection of alcohol, and no more permanent, hence the latter method must be preferred because of its ease and safety of application.

RESECTION OF THE INFERIOR DENTAL AND LINGUAL NERVES

In our practice these two branches have always suffered simultaneously, so that we have never been forced to operate only upon one or the other singly.

Both of these nerves may be approached conveniently through an opening in the lower jaw. An incision is made along the lower border of the jaw, beginning at a point a little behind the angle and extending forward an inch-and-a-half. This incision is carried down to the bone. The periosteum, together with the attachment of the masseter muscle, is then pushed upwards by means of a chisel and an opening one-fourth of an inch in diameter is made exactly in the middle of the ascending ramus of the jaw by means of a small trephine or a gouge. This will expose the inferior dental nerve. The nerve is picked up with forceps and drawn out through this opening. Then



a pair of hemostatic forceps is placed upon the nerve and gentle traction made forwards and downwards to loosen it as much as possible. A second incision is then made directly opposite the mental foramen. The mental nerve which issues from this foramen is readily found. It is picked up on an elevator and severed. The portion between the mental foramen and the trephine opening is then drawn out of this opening. Traction is made upon this portion of the nerve and as much as can be drawn out of the foramen is cut off. In such manner the entire portion of the nerve within the canal in the lower jaw is removed. A small, blunt hook is then inserted through the foramen and passed around the lingual nerve, which is drawn out through the trephine opening, caught with hemostatic forceps, and as much as can be drawn out by pulling upwards and downwards repeatedly, is withdrawn through the trephine opening. It is then cut loose on the distal side and the nerve is again caught with a pair of artery forceps, which are twisted slowly, so that the nerve is rolled upon the forceps like rope upon a windlass. In this way a considerable portion of the nerve can usually be drawn out.

We believe that in our early cases we failed to remove a sufficient portion of each nerve, and consequently experienced recurrence in some cases, much more frequently than we have since performing this more thorough operation.

RESECTION OF THE INFRAORBITAL NERVE

The infraorbital nerve is the most common seat of trifacial neuralgia, according to statistics found in literature, but in our own experience it has been less frequent than in the inferior maxillary branch.

The simplest method of approaching this nerve consists in making an incision along the lower edge of the orbit three-fourths of an inch in length, directly over the infraorbital foramen, which can readily be located by making pressure along this margin of the orbit and determining the most painful point. Care should be taken to make this incision slowly, in order not to sever the infraorbital artery at the point at which it issues from the foramen, as this would cloud the field of dissection with blood. The three branches—the supramaxillary, sphenopalatine and infraorbital nerves—usually do not separate before issuing from this foramen, but caution should be observed in making the dissection, not to overlook one or the other of these branches in case division has taken place before exit from this foramen.

When the nerve has been laid bare it should be picked up on a dissector. (And we would state here that the most convenient instrument for dissecting out nerves which we have encountered is the old-fashioned dental excavator, which is fine enough to serve properly and still contains sufficient strength to be useful.) If the foramen is complete its upper portion is chiseled away, transforming it into a groove. The nerve is then grasped with a pair of hemostatic forceps and drawn upward, and its branches are followed with a dissector and successively cut away at a distance of about three-fourths of an inch from the foramen. Careful traction, which is frequently repeated, is then made upon the nerve with the forceps. In this manner more and more of the nerve can be withdrawn.

If the neuralgia has been severe it is well to chisel away the upper wall of the canal with a blunt raspatory after loosening the periosteum overlying it. A narrow retractor is then inserted underneath the periosteum and while traction is made upon the nerve a narrow pair of scissors is inserted and the nerve is cut off a considerable distance from the infraorbital margin.

EXCISION OF THE SUPRAORBITAL NERVE

The operation which has just been described is also performed for the relief of supraorbital neuralgia, with the exception of making an incision along the supraorbital margin after shaving away the eyebrow. If the incision is made directly through the middle of the eyebrow, and parallel to it, it leaves no deformity.

These three operations last named are relatively simple and safe. They give rise to no deformity, and unless the antrum of Highmore is opened in chiseling open the infraorbital canal the wounds all heal rapidly and perfectly. In case any one of these procedures has been performed and there is a recurrence of the neuralgia the undertaking may be repeated and a second attempt may result more favorably. If, however, a radical cure of the condition is desired, then it is best to excise the sensory root of the Gasserian ganglion.

HARE-LIP

Best time for operating and preparation. In uncomplicated cases of hare-lip the sooner the operation is performed, the better it is for the infant. This should be done some time during the first ten days. In cases associated with cleft-palate, especially if this be complete, it is better to follow the method devised by Brown, which consists of placing a strip of zinc oxide adhesive plaster across the lip fissure, making it about the width of the upper lip and extending sufficiently across the cheek from each side to give firm resistance when tightly drawn. The strap is reapplied daily until the operation is performed.

The advantages of this preliminary treatment are that it not only prevents an increase of deformity and further distortion of the face by unnatural muscular action, but it has a tendency to correct the deformity, as in crying and laughing the principal force of muscular action is applied to the most prominent anterior portion of the maxillary bones, which in double hare-lip and cleft-palate is the mandibular process.

It also has a decided effect in the single cases, as in all of them the maxilla is more prominent on one side than on the other, and the strap has the tendency to depress the more prominent side and to bring the shorter side forward. Furthermore, the infant becomes accustomed to take nourishment with the lip in a condition similar to that after operation, and to breathe through the reduced air space. After the daily application of the adhesive straps for a period of ten days or two weeks, the above advantages will have been gained and the defect in the lip should be closed.

Technique. The steps of the operation should be planned so that after closure of the fissure there will be practically no scar and as little deformity of the lip as possible. The freeing of the lip from the cheek is one of the most important parts of the operation, for unless this is thoroughly done it will be impossible to bring the edges of the lip together without tension, which is apt to result in a failure of union, or in the production of scars caused from cutting of the tissues by the stitches.

After the lip has been thoroughly loosened the edges of the cleft in the lip must be prepared for suturing. This is accomplished by using a very sharp, thin-bladed scalpel, with which a thin strip of tissue is excised from the border of the lip on each side of the fissure. The dissection is commenced at the upper border of the lip and carried downwards, removing a very thin layer of tissue. The mucous membrane from the lower one-half centimeter of the lip is not excised, but is left as a wedge-shaped projection at each corner of the lip. When the lip is sutured these two wedge-shaped

corners are brought together and form a slight projection downwards, which will prevent the formation of a notch as the scar contracts. This also helps to broaden the lip.

If the lip is too narrow, it may be broadened by making a curved incision in excising the mucous membrane, having the convexity of the incision toward the cheek on each side, thus removing only a thin strip of mucous membrane at the upper and lower corners, and a strip of about one-half centimeter wide from the center of the lip. As the two concave surfaces are brought together it will broaden the lip. In closing the lip the sutures should be placed with great care and without tension. Two tension sutures of silkworm gut threaded in a fine needle should be placed first. The needle enters the skin about one centimeter from the edge and is carried in an oblique direction and emerges from the lip just at the edge of the mucous membrane of the posterior surface of the lip. It is then passed into the edge of the lip on opposite side, entering at the edge of the mucous membrane and emerging at a point one centimeter from the border on the skin surface. These two sutures are left untied until the coaptation sutures have been placed.

The mucous membrane of the lip is now sutured with fine catgut throughout, and the edges of the skin coaptated by placing a few horse-hair stitches. The tension sutures are then tied, but care should be given not to tie them too tightly. Adhesive strips should now be applied, so as to take all the tension away from the stitches. The stitches should be removed at the end of a week, but the adhesive strips should remain in place for two or three weeks.

DOUBLE HARE-LIP

In cases in which the prolabium has been left, it is usually advisable to depress this projection somewhat, and then utilize it as a central island in the formation of the new lip. The mucous membrane should be dissected off of the three borders of the prolabium, and from the two borders of the lip. An incision about one-half centimeter long should be made in each lip a little below its center and at right angles to its freshened edge. The upper half of the lip is now sutured to the lateral borders of the prolabium, and the edges of the "lower" half of lip are sutured to each other in the mid line and above to the lower border of the prolabium.

CLEFT-PALATE

If a hare-lip is associated with a cleft-palate, the lip should be repaired immediately, or some time during the first three weeks of life, and the cleft in the palate left until some later time.

Differing opinion as to best time of operating. Authorities are evenly divided on the question of time for operating for closure of the palatine cleft; many of them recommend that the palate be closed in infancy, and this done before closure of the hare-lip. The advocates of the early operation advise that the palate should be closed during the first three months after birth; that there is less shock at this time of life because the child's nervous system is not fully developed; that there will be the minimum amount of deformity, for they claim that all of the tissues, both bony and soft, will develop more naturally after the cleft is closed, and that this development will allow a normal speech to follow when the child reaches a speaking age.

The question of mortality in these infants is an important one. There is no doubt but that these little patients are better able to stand an operation of this kind at the age of eighteen months, than they are during the first few

months of life. Furthermore, children during their first year are more subject to toxemias than older ones, and are apt to develop intestinal troubles following the operation, which are likely to add to the mortality. It is the authors' custom to close only the fissure in the alveolar process before the age of eighteen months, and to leave the remaining portion until such time as the child makes an attempt at talking. We also caution the parents of such children against encouraging them in these attempts, because our results have been more satisfactory when the operation was performed at the age of eighteen months or two years than when the repair was attempted in very young children; moreover, the mortality in children at this age has been practically nothing, while in those younger it has been considerable. In older children it is difficult to secure perfect speech unless great pains are taken in giving them instruction.

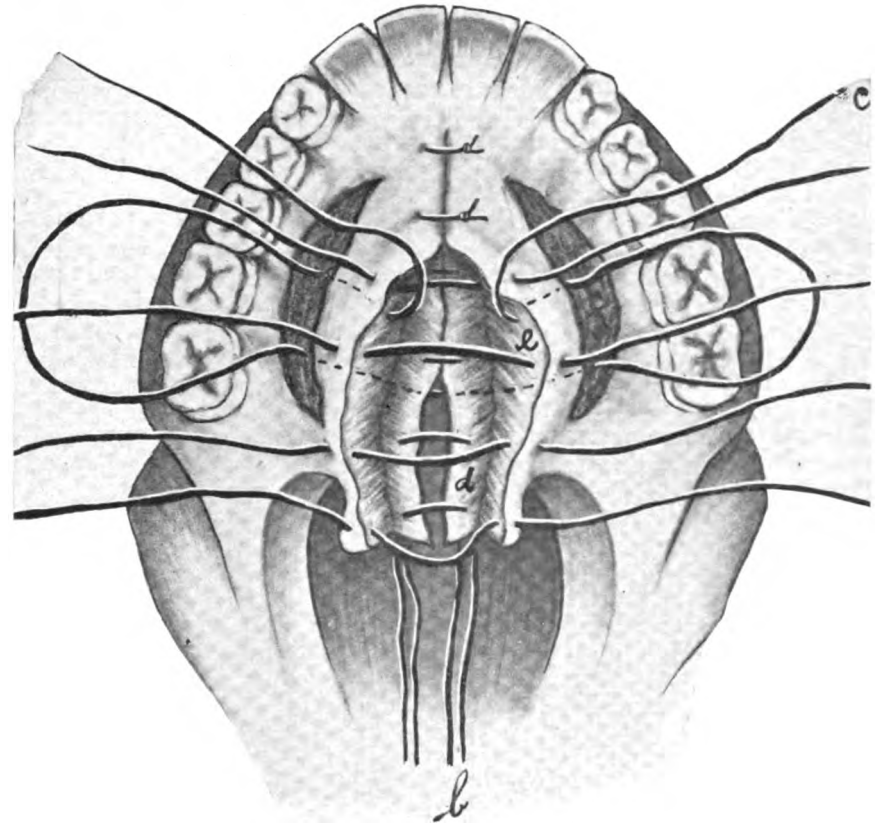
Effect of training upon speech. The following observation, however, has convinced us that it is possible to get these children to speak very nearly perfectly if a sufficient amount of care and patience are employed. If children should have learned a given language before the operation was performed and have later learned another language, we have found that the language which they learned later was spoken perfectly, while the defects noted in the language learned before the operation were likely to persist. It is consequently plain that if these children were taught to relearn their language that with care they could accomplish a great deal. This we have found to be true in practice and we would consequently advise a systematic course of instruction in the formation of those sounds in the utterance of which the soft palate is involved. Some especially gifted teachers have succeeded in producing perfect results whenever the child has possessed a sufficient amount of intelligence to appreciate the instruction, and the necessary perseverance to carry it out.

Technique. Certain conditions are obviously necessary in order to insure success from any of the various operations which have been devised for closure of cleft-palate, namely: The naso-pharynx must be in a fairly healthy condition; the operator must prepare broad edges of the flaps to be united; the flaps must be sutured carefully and without tension; one must traumatize the tissues as little as possible; must keep the parts as clean as possible after operation, and it is important to keep the parts relatively quiescent after operation.

The success of this operation depends largely upon the thoroughness with which the flaps are loosened, and if the surgeon appreciates the fact that his operation is not likely to succeed so long as there is any tension upon the stitches which unite the edges of the wound in operations for the relief of cleft-palate, he has grasped the most important principle in this operation. The method of the operation will vary with the extent of the cleft. If this is only through the soft palate, it is wise to split the edge of the cleft throughout its entire extent, beginning at the tip of the uvula on one side, extending this incision around the entire cleft to the tip of the uvula on the other side. This produces a broad surface for coaptation. It is necessary to make use of an exceedingly sharp scalpel in order to accomplish this incision satisfactorily. After this has been accomplished, a method must be adopted for loosening the flaps on either side so thoroughly that they will come together without the slightest tension. This can be brought about by making two lateral incisions along the outer edge of the palate and loosening the soft tissues by means of an elevator, or a small chisel may be applied to the alveolar process of the palate bone, and this may be chiseled off, as shown in the accompanying drawing.

It matters little how large an incision or opening is made upon each side, provided the flaps can be sufficiently freed so that they will come together without injury. The lateral incisions will invariably heal spontaneously.

Involvement of hard palate. In case the cleft extends into the hard palate, or through the hard palate, the following method has been most satisfactory in our hands, although it is more troublesome than some of the other procedures that have been found equally useful by other surgeons. The incision



CLEFT PALATE OPERATION.

(a) Shows sutures on mucous membrane turned into nasal cavity; (b) sutures on flap turned into the cavity of the mouth; (c) the silkworm gut suture which holds together the bone flaps; (d) flap turned into the nasal cavity; (e) flap turned into cavity of mouth; (f) incision through hard palate. In order to make the conditions clear the drawing was made to represent only the lower surface of the upper jaw with the hard and soft palate.

is made under the alveolar process on each side. A broad, thin chisel is placed in this incision and the horizontal portion of the palate is chiseled away so that there is a perfectly loose flap, consisting of mucous membrane of the mouth, the bone of the palate and the mucous membrane of the nasal cavity attached only in front and behind. If one side or the other is attached to the vomer this attachment is also loosened. If this flap is made so loose on each side that it can be carried over to the flap on the other side without the use of any force, then one may usually count on a successful result.

Hemorrhage. The hemorrhage in this operation is considerable, but it can readily be controlled by means of a tampon. The patient is in the Trendelenburg position, with the head projecting beyond the table; consequently there is no danger of the inspiration of blood. After these flaps have been made the fissure which has been formed under the alveolar process should be thoroughly tamponed with iodoform gauze and the flaps should remain undisturbed for one or two weeks, the nose and mouth being frequently irrigated each day with normal salt solution. At the end of this time the flaps are usually very vigorous, and readily heal if the edges are freshened in the manner we have just described in connection with operation for cleft of the soft palate.

Sutures. The most satisfactory suture material in our practice has been horsehair, because it is slightly elastic, stretching sufficiently to prevent pressure-necrosis. Of course, it is necessary not to tie these sutures tightly, as the same elasticity which would be useful if these sutures are tied loosely would then become harmful, for it would increase the amount of pressure-necrosis precisely after the manner of an elastic ligature. It is well to remember that the fewer the number of sutures that will suffice to secure perfect apposition the greater will be the likelihood of union.

In order to hold the bony portion of the flaps in position it is well to pass around them one or two stitches of silkworm gut, which should be tied just tightly enough to hold the tissues together and not tightly enough to cause pressure-necrosis, because the latter condition is likely to result in a complete severing of one or both bony flaps. The fissures under the alveolar process should again be carefully tamponed with iodoform gauze. If the fissure extends through the alveolar process in front, this should be mobilized on either side some distance back from the fissure by means of a chisel applied between the teeth, and then the edges should be united at the point of fissure by means of a catgut suture.

In children who are not old enough to remain perfectly quiet during the removal of the stitches it is best to administer an anesthetic when the stitches are removed, for fear of disturbing the line of union. If possible, the sutures should be extracted on the fifth or sixth day, as if they are left longer they sometimes result in sloughing.

Brown operation. Of late the authors have done the operation as devised and practised by Dr. G. V. I. Brown, and with excellent results.

The operation is based upon the fact that all of these patients have a high arch, which increases the diameter of the mouth, and that by lowering the roof of the mouth the necessary width for closing the fissure is obtained. The technique is as follows. A short incision is made along the margin of

the alveolar process, extending down through the periosteum of the hard palate. A small, thin chisel is then inserted down to the botom of this incision and the tissues of the roof of the mouth, together with the periosteum of the palate bone, are thoroughly loosened from the edge of the cleft back to the alveolar process. Both sides are treated in the same manner. The edges of the palate tissue are now carefully trimmed off in a manner so as to secure broad surfaces for coaptation. A fine silver wire, with a silver plate about one centimeter in diameter fastened to one end, is now passed through the flap on one side at a point about one centimeter from its inner margin,

and then carried across and brought up through the opposite flap at a corresponding point, and left loose until the coaptation sutures have been placed. The edges of the two flaps are now very carefully united by horse-hair or fine silk stitches, being very cautious not to draw them tight. A silver plate about a centimeter in diameter is now threaded upon the free end of the silver wire, and then three or four drilled shot are threaded down on top of the plate. The object of using several of the shot is to be able to obtain the exact tension desired on the silver stitch. The outermost one of the shot is now crushed, and then the tissues tested for the desired tension. If the tension is not enough the other three shot are pushed down a little and the next crushed onto the wire. As soon as the desired tension is secured the innermost shot is crushed and the superfluous wire, together with the other three shot, are removed. It is usually necessary to make one or two lateral incisions through the flaps along the alveolar process in order to relieve any possible tension that may be present. The stitches should be left in place about seven to ten days, cleansing and spraying daily.

Lane's operation. In some patients, where the cleft in the palate is very wide, the closure can best be made by Arbuthnot Lane's urano-plasty. The operation consists in inverting inwards toward the median line a flap composed of all the soft tissues of the roof of the mouth, the pedicle, or hinge, of the flap corresponding to the edge of the cleft, and suturing the edge of this flap underneath a flap of the soft tissues from the opposite side of the palate.

Technique. An incision is made along the margin of the alveolar process on one side through the muco-periosteum, and is carried back into the soft palate, going through the mucosa of the soft palate, but not injuring its musculature. From the hard palate a muco-periosteal flap is loosened, and from the soft palate the flap consists of mucosa and submucosa, the dissection of both being carried toward the mid-line, leaving the edge of the cleft as a hinge for the flap. The other flap is prepared by grasping the uvula and soft palate with a pair of forceps and pulling it forward to expose the nasal side of the soft palate. An incision through the mucosa is made along the posterior edge of the soft palate, where it is carried forward along the edge of the hard palate. A mucosa flap is now reflected from the nasal side of the soft palate, and a muco-periosteal flap from the hard palate, the same as on the opposite side, except the dissection is begun from the mid-line and carried outwards, leaving the pedicle, or base of the flap, along the alveolar border, instead of the inner margin of the cleft, as on opposite side.

The first flap is now inverted, so that its epithelial surface is toward the nose and its raw surface toward the mouth. The edge of this flap is now tucked under the edge of the second flap and sutured to its under surface by a double row of fine silk or horsehair sutures. In this manner very large clefts can usually be closed without any tension, insuring primary healing throughout. The denuded surface left in the roof of the mouth heals over very rapidly.

Fistulæ following operation. It happens occasionally that a fistula remains in some portion of a wound which has been sutured. This may be due to the cutting of a stitch, or there may have been a certain amount of tension which prevented union, or there may have been a slight amount of infection. If these fistulæ are painted every day with tincture of cantharides they are likely to unite very rapidly. If it fails to unite after this treatment has been tried for several weeks it is best to leave the fistula for a number of months until the surrounding tissues have become quite normal, and then to make a longitudinal incision on each side of it and to loosen enough of the soft tissue to permit the two sides to come together in mid-line without any

tension. These incisions should be long enough to make the flaps perfectly free. Then the fistula is freshened and united by means of a stitch. Occasionally it seems better to make a horseshoe-shaped incision around one or the other end of the fistula and thus to loosen a one-sided flap which will heal directly over the opening.

EMPYEMA OF THE ANTRUM OF HIGHMORE

For the relief of empyema of the antrum of Highmore the most convenient and satisfactory point of approach is through the canine fossa. A longitudinal incision is made parallel with the alveolus of the upper jaw, two centimeters in length, at the point at which the mucous membrane extends from the jaw to the cheek. The periosteum is elevated for a distance of two centimeters and is held out of the way by means of retractors. Then an opening one and one-half centimeters in diameter is made by means of a gouge, the ordinary carpenter's chisel and mallet again being used. The cavity is then carefully curetted, first with a large and then with a small curette; then it is repeatedly sponged out with a dry gauze sponge, which will remove any granulations or remnants of polypi. Then the entire cavity is sponged with a piece of gauze slightly moistened with ninety-five per cent. carbolic acid, or, better still, the entire cavity is tamponed full of a strip of gauze moistened in this manner. This tamponing is repeated a number of times, so that all the lining of the cavity of the antrum has been kept in contact with the strong carbolic acid for a period of about five minutes. Then it is tamponed several times with a strip of gauze saturated with strong commercial alcohol in order to wash away any superfluous carbolic acid. After this the cavity is tamponed with iodoform gauze saturated with tincture of benzoin. This may be left in place for a number of days, the antiseptic qualities of benzoin being sufficient to prevent the cavity from becoming foul. After this has been removed it is usually sufficient to insert a small, self-retaining rubber canula through which the antrum may be irrigated daily with some mild antiseptic fluid. If the infection of the antrum has not been of long standing it is not necessary to make so radical an operation, the simple opening, irrigation and drainage of the cavity often sufficing.

In old cases it is well to remove the separating bony wall into the nose for permanent drainage and for the purpose of obtaining an easily accessible opening through which the cavity may be cleansed.

Beck's bismuth paste. Since the introduction of Beck's bismuth paste we have had excellent results in the after-treatment of these cases by tamponing the cavity with gauze filled with this paste, once in two or three days, and later by injecting the paste through the artificial opening and then closing this opening with a small gauze tampon. This treatment is repeated daily at first and less and less frequently later on.

Mild cases will recover if the antrum is filled in the same manner with Beck's bismuth paste through a canula introduced through the nose, without making an artificial opening into the antrum, the nostril being tamponed with gauze after filling the antrum.

Except in cases of very long standing it is advisable to try this method first, for a few weeks, instead of at once choosing the operative treatment. In case the antrum contains neither polypi nor necrosed bone the suppuration decreases rapidly, and then the injections should be made less frequently. It is wise, however, to inject the bismuth paste once a week after the condition seems normal.

EMPYEMA OF THE FRONTAL SINUS

The treatment which has just been described for empyema of the antrum of Highmore is equally applicable to this condition.

After thoroughly disinfecting the nose, a canula is carried up into the affected sinus and the latter is filled with Beck's bismuth paste under very moderate pressure, the paste being heated to 110° F. It is important to inject the fluid slowly and to continue the injection for several minutes in order to fill every portion of the cavity. In case it is not possible to pass a canula of about 2 mm. diameter through the nose into the frontal sinus, a passage should be made with a fine bone curette, or, if this is not possible, with a fine gouge. This can be done under local anesthesia with cocaine, or general anesthesia with ether may be employed. Extreme care and an accurate knowledge of the anatomy of this region are required, as there is danger of perforating the inner table and causing meningitis, which is usually a fatal complication.

After the sinus has been filled with the bismuth paste the nasal cavity is tamponed with gauze which has also been saturated with the paste, which will serve to keep this cavity as nearly aseptic as possible.

INFECTION OF THE ETHMOID CELLS

In many cases this affection precedes, accompanies or follows the condition just discussed. The treatment depends, as in the two previous diseases, upon disinfection and drainage, the latter in most instances accomplishing the former. Recently operations upon these cells have been undertaken in many cases, which would undoubtedly have recovered perfectly and permanently without the necessary defect following an operation, had the patient's general state of health been more carefully directed. This is especially true regarding habitual errors in respiration in many of these patients. Their breathing is habitually so shallow that they never either fairly fill or empty their lungs, and consequently leave the mucous surfaces constantly congested. By instructing them to inhale to their fullest capacity and then forcibly blow out the air through a small glass tube until their lungs are as nearly empty as possible, doing this many times a day, these surfaces clear up rapidly, and in early cases, if this practice be continued, we have seen many who have remained permanently well, so far as their ethmoid cells were concerned, while their general health was vastly improved. Of course, the diet and habits of work and sleep, as well as the ventilation of living and sleeping rooms, must be regulated at the same time.

Technique. Under local anesthesia with two to five per cent. cocaine injected through a fine, long needle, it is possible to secure satisfactory drainage by curetting away the infected cells with a strong, fine, sharp curette, or to bite them away with strong, sharp, gnawing forceps. A dry tampon is first applied and left in place for at least five minutes, then the space is tamponed with gauze saturated with compound tincture of iodine, and then with gauze saturated with Beck's bismuth paste. In obstinate cases two to ten per cent. of nitrate of silver solution may be used on the tampon, or 10 per cent. solution of argyrol.

It is important to bear in mind the relation between these cells and the meninges, because it has repeatedly happened that an inexperienced operator has caused a meningitis by carrying his manipulations too far.

Frequently the infection of the ethmoid cells is due to an infection caused by the presence of nasal polypi. These may produce the infection simply from an extension of this process, or the natural drainage may be interfered with owing to a blocking of the nasal space due to the presence of polypi.

NASAL POLYPI

Usually patients do not come under the surgeon's care until nasal polypi have attained a sufficient size to cause obstruction.

Under cocaine or novocaine anesthesia the pedicle of the polypus can usually be grasped with curved polypus forceps passed through the nares under the guidance of the index finger introduced through the mouth. The smaller polypi must be removed by means of a polypus forceps through a nasal speculum with illumination from a head-mirror. Freer's instruments seem most convenient for this purpose. This and the previous operation are accompanied by severe hemorrhages which may necessitate performing the operation in several stages, with intervals of several days.

It is possible in most cases to do the operation at one sitting by tamponing the surface with gauze and interrupting the operation temporarily while this is being done, but the effect of this plan is often not borne well by the patient.

POST-NASAL ADENOIDS

The removal of these structures is usually accomplished at the time of some other operation, like excision of tonsils or of tuberculous lymph nodes of the neck.

The patient is placed in Rose's position upon his back with the head projecting dependently beyond the end of the table, and held firmly between the hands of an assistant. Either general or local anesthesia may be employed. The uvula is drawn forward with the index finger of the left hand and the adenoids on the posterior wall are cut away quickly by means of a Gottstein curette.

A small ordinary curette is then introduced, first through one and then through the other nostril, and all of the remaining adenoids are curetted away carefully under guidance of the left index finger. It is important to protect the opening to the Eustachian tube with the end of the index finger.

The entire surface is then very vigorously rubbed with the index finger covered with a few thicknesses of sterile gauze.

The patient's diet and hygiene are carefully controlled after the operation and especial stress is laid upon the practice of breathing exercises.

CONTRACTED NARES

Nares which have been contracted because of former injuries to the nose should be treated by forcibly loosening the displaced bony structures and then treating the condition as one would a fractured nose primarily.

FRACTURE OF THE NOSE

In the treatment of this accident two results must be constantly borne in mind: 1. The patient must be able to breathe through both nostrils after recovery. 2. He must not remain unreasonably deformed.

The first object may be accomplished by applying suitable perforated intranasal splints made of hard rubber, aluminum or silver. The latter purpose is fulfilled by carefully regulating the support to the external surface of the nose throughout the process of healing by applying pressure pads at the necessary points. It requires much ingenuity to improvise means and methods suitable for the individual case.

DEFLECTED SEPTUM

In occasional cases what has just been said applies with equal force to this condition. By grasping the deflected septum with strong forceps and thoroughly fracturing it, so that it ceases to take upon itself its former deformity, and then applying the same intranasal splints for a month, excellent cosmetic and functional results may be looked for.

In the majority of cases, however, the best results are obtained by making a submucous resection of the septum, or a portion of it. This is easily accomplished under local anesthesia. A four per cent. solution of cocaine is applied to the mucous membrane over the septum and then some one-half per cent. novocain solution is injected underneath the mucous membrane, between that and the cartilage. This not only makes the anesthesia more complete but facilitates the separation of the mucous membrane from the cartilage. An incision is now made along the junction of the mucous membrane of the septum with the skin, and then by means of a small, thin elevator the mucous membrane is readily separated clear back to the bony septum. An incision through the cartilage is now made along its anterior border, being careful not to cut through the mucous membrane on the opposite side. The mucous membrane can now be readily loosened from the other side of the cartilage. A Ballinger swivel septum knife is now inserted and as much of the septum as desired is rapidly removed. A small tampon of gauze placed in the anterior nares holds the flap of mucous membrane in place without the application of any sutures.

SADDLE-NOSE

If this condition is due to an old fracture this should be refractured and then replaced as nearly as possible, and then the case should be treated according to the method already described. If it is congenital, then it is sometimes best to correct the deformity by the use of paraffin injections.

Traumatism is the most common cause of saddle-nose, and next in frequency comes syphilis, either acquired or congenital. It may also result from simple abscess of the septum. Any condition causing destruction of the nasal septum, may result in this deformity, as that removes the support of the nasal bones and cartilages.

Several methods of correcting this deformity have been devised, such as inserting plates of celluloid, platinum or silver underneath the skin as a substitute for the natural bridge of the nose, but none of these is as satisfactory as the transplantation of a piece of a rib or costal cartilage to replace the contour of the nasal bones. In the authors' experience the use of the cartilage has proven the most satisfactory of the two.

TECHNIQUE OF TRANSPLANTING CARTILAGE

A small, transverse incision 1 cm. in length is made across the base of the nose extending down to the bone. Then by means of a small, thin elevator the skin and subcutaneous tissue are carefully raised from the nasal bones, being cautious to make the separation in the mid-line only, and not loosen the tissues from the side of the nose. The dissection is carried far enough toward the tip of the nose so that when the undermined tissue is elevated the deformity will be entirely corrected. An estimate is now made as to the size of the piece of cartilage necessary to replace the bridge of the nose. An incision is now made over the costal cartilage of the seventh or eighth ribs, and the cartilage removed. By means of a sharp scalpel the cartilage is cut into

the shape and size estimated necessary to correct the deformity when inserted into the nose. The cartilage is now grasped with a small pair of forceps, and while the small skin incision over the base of the nose is held open with tenaculum forceps, the cartilage is slipped down underneath the soft tissue of the nose, resting upon the nasal bones and the septum. The incision is now closed with one or two horsehair sutures. It is quite remarkable how nearly some of these saddle-noses can be restored to normal.

Use of paraffin. This method of treatment is very simple, and there is no resulting scar from its use. It has a further advantage in that it causes very little reaction of the tissues and does not necessarily confine a patient to the house, thus allowing him to immediately resume his daily pursuits.

Although the treatment is very simple, still there are some dangers connected with the use of the paraffin. The chief dangers are abscess formation and sloughing of the tissues from infection, also sloughing from pressure-necrosis from hyper-injection. A few cases of embolism have been reported immediately following injection for deformity of the nose.

Technique. If the patient is an adult and is not particularly nervous, the paraffin may be injected without the use of a general anesthetic. In such it is well to administer a quarter of a grain of morphine hypodermatically half an hour before the treatment is to be given. The majority of patients prefer to take a general anesthetic, the after-effects of which are very slight, because the patient is anesthetized for only a few moments.

It is very important that absolute asepsis be carried out during the process of injection, for the slightest infection is apt to result in abscess formation and sloughing of the tissues. A special syringe should be used so that the paraffin can be forced out through the needle after it has hardened, and also so the paraffin may be injected very slowly. The syringe should be constructed of metal and fitted with a thumb-screw upon a worm on the piston-rod, which can be screwed into the head of the syringe after it has been filled with melted paraffin. A good-sized ring should be firmly attached to the distal end of the piston-rod so that the piston-rod may be turned easily, which will gradually lower the piston and force the paraffin out through the needle in the shape of a cylindrical thread. The syringe as devised by Harman Smith has proved very satisfactory to the authors.

The paraffin should be thoroughly sterilized, and is then maintained in a liquid state by keeping in a hot water bath until used. The paraffin is now poured into the syringe, and allowed to solidify before injection. The needle on the syringe should be about two inches long and should be inserted from above downwards; that is, toward the tip of the nose, so that the injection will be made toward the tip of the nose and not toward the base. In the few cases of embolism of the central artery of the retina immediately following injection of paraffin for correction of nasal deformity, each injection was directed toward the root of the nose instead of toward the tip. The skin over the base of the nose, a considerable distance above the depressed portion, should be grasped between the thumb and finger of the left hand, and the needle introduced through the skin at this point, then the needle is passed downwards along underneath the skin to a point near the lowest part of the depression. An assistant now grasps the nose at its base just above the depression to prevent the paraffin from backing up above the depression. The piston-rod of the syringe is now turned slowly, and as the paraffin enters the tissue it is gently molded into the proper shape. Care must be used not to inject too much paraffin. When the skin over the area of injection becomes white the injection should be stopped. If the depressed area has not been raised sufficiently, it is better to inject a second or third time than to cause too much tension by injection of a large amount primarily. Care must also

be used to have the paraffin lodge in the right place, otherwise the deformity may be increased. After the injection the needle puncture is sealed with collodion, and no further dressing applied.

FOREIGN BODIES IN THE NOSE

Ordinarily it is possible to remove foreign bodies from the nasal cavity without difficulty by the use of forceps, blunt curettes or wire loops, but if they have been in position long enough to cause edema, necrosis or suppuration it is often difficult to accomplish their removal.

This is also the case if the patient has had foreign bodies forced into the nose during explosions, or railway, automobile or runaway accidents.

We have removed nails, stones, and, in one case, a piece of wood 4x1.5x.5 cm. in diameter from the noses of such patients.

In these cases general anesthesia, followed by a careful exploration, is necessary. After removal of the foreign body the space should be carefully tamponed to prevent infection and hemorrhage.

EPISTAXIS

Following the various operations in the nasal cavity, and sometimes independently, patients suffer from severe hemorrhages from the nose, which may be almost uncontrollable. But we have always succeeded in overcoming the hemorrhage, even in the most desperate cases, by taking a piece of soft gauze 24 cm. long and 12 cm. wide, and folding it upon itself so as to make a bundle 12 cm. long and just thick enough to occlude the posterior nares. The width must vary slightly with the size of the patient, and the length with the quality of the gauze. Two pieces of double silk are tied about this gauze so as to divide it into three equal portions. A small soft-rubber catheter is now passed through each nostril and guided out through the mouth, then one piece of the silk is tied to each catheter and pulled forward through each nostril, the gauze being guided into place with the index finger. The two strands of the double silk are then separated and a pledget of cotton sufficiently large to close the nostril is tied into this string on each side, the gauze being carefully adjusted in the posterior nares in the meantime so as to occlude these completely.

The nostrils will become filled with blood and this will form a plug which will supply the necessary pressure to control the hemorrhage. The strings should be tied over the anterior plugs in such a manner that they can be readily untied in two or three days for the removal of the plugs. If the bleeding vessels have not been occluded hemorrhage will recur at once, or after a short time, and then the anterior plugs will have to be renewed.

CHRONIC RECURRENT EPISTAXIS

This condition is usually due to anemia and should be treated with internal remedies, diet and hygiene. In other cases it is due to an erosion of some vessel in the mucous lining of the nose. In such event the bleeding surface should be touched with the electric cautery under local anesthesia.

FRACTURES OF THE LOWER JAW

In the treatment of fractures of the lower jaw the fragments may be held in position by making use of the upper jaw as a splint, by forming a splint of strong wire covered with fine rubber tubing and applying it along the alveolar process, either to the inside or outside of the teeth, or upon both sides, and holding the fragments in place by winding wire about the splint and the teeth. A grooved metal or hard-rubber splint may be employed to

envelop the teeth. Gold rims may be placed on a number of teeth and these may be held in position by means of screws. A horseshoe-shaped splint may be fitted externally to the lower jaw and held in place by means of bandages, or it may be adjusted mechanically like the ingenious splint introduced by Matas.

Two conditions must be borne in mind which are peculiar to fractures of this bone: First, the proximity to the cavity of the mouth which always contains pathogenic micro-organisms; second, the fact that the fracture must be so dressed that feeding of the patient is possible. The mouth should be frequently irrigated with normal salt or with boric acid solution, and provision should be made for passing a tube into the pharynx through which the patient may receive liquid nourishment at regular intervals. Usually there is a space between the teeth, but if this does not exist a tube can be carried around the teeth into the pharynx.

In a large proportion of these cases there is a communication between the fracture and the mouth cavity. Fortunately for the patient, infection of these compound fractures seems less harmful than in other bones.

TUMORS OF THE JAW

The most common tumor of the jaw affects the alveolar process. It begins as a hard, fibrous mass near the root of a tooth, called an epulis, and progresses into the substance of the jaw, the tooth becoming loosened, and may develop a growth of considerable size. Presently it advances along the mucous membrane of the mouth and later it may extend into any of the surrounding tissues. During the early part of its development this tumor is composed of only fairly-developed connective tissue cells. As it advances these become more and more embryonic until the growth has the appearance microscopically of a spindle-celled sarcoma. If it is partly removed its growth seems to be greatly stimulated, and if removed incompletely several times it will progress in the usual course pursued by a sarcoma.

Technique. To make room, one or two teeth should be extracted beyond each end of the growth, the entire alveolus should then be chiseled away deeply and the soft tissues covering the jaw should be removed, together with the bone. Then the entire area should be thoroughly cauterized either with a Paquelin cautery or with a cautery-iron of considerable size which has been heated to white heat in a flame. The thorough destruction of the deep tissues by means of the cautery seems to be the important part of this operation. If this is done reasonably early these growths practically never recur.

In many of these cases that have come early we have been able to cut away the growth, together with the underlying periosteum, with a sharp chisel and then at once produce a deep scar with the actual cautery without being compelled to remove even a single tooth. This should always be done under general anesthesia, because otherwise one is likely to cauterize too superficially. In the presence of doubt one should, however, never hesitate to remove one, or several, or even all of the teeth. Thoroughness means success in this operation.

DENTIGEROUS CYSTS OF THE JAW

The retention of the embryonic teeth within the jaw gives rise to the formation of a bone cyst. It is frequently difficult to differentiate this from sarcoma, except through the history, although the cyst wall usually yields under pressure with the finger placed upon the inner side of the jaw, giving rise to a crackling sensation. The patient is frequently aware of the presence of a swelling for months or years before the physician is consulted. Were he suffering from a sarcoma there would be secondary involvement long be-

fore this time. During the early part of the development of a cyst of the jaw, however, it is not possible to make a positive diagnosis. There is always an unerupted tooth as the cause of this affection, but so few patients keep an accurate record regarding the number of teeth they have had extracted that one cannot make any reliable calculations from the number of teeth that are left.

Technique. The jaw should be chiseled open either from below, an incision being made through the skin and periosteum and the latter reflected, or from the mouth, one or two teeth being extracted to make room for the operation. The cavity is carefully chiseled out, tamponed, and permitted to heal by granulation. Usually some remnant of the embryonic tooth is found. The prognosis is good.

Frequently these cases come under the care of the surgeon after they have been operated, showing only a sinus leading down to the denuded bone, which we have often discovered to represent the lining of the infected cyst, but more frequently we have found a portion of a tooth or a partly-developed tooth at the bottom of the sinus.

SARCOMA OF THE LOWER JAW

The only treatment that promises relief in sarcoma of the lower jaw is the excision of the entire half of the maxilla involved. This is accomplished by making an incision along the lower border of the jaw from the angle thereof to a point beyond the middle line of the chin. The soft tissues are carefully separated, the mouth opened, a tooth is extracted opposite the point at which the jaw is to be separated, and then a chain saw or a wire saw is carried around the bone, and while the wound in the skin is retracted in order to prevent its injury, the bone is sawed off. The end of the jaw is then grasped in a pair of lion-jawed forceps and carried out through the wound in the skin. If the tumor is located near the angle of the jaw it is best to remove the entire half of the maxilla, making an ex-articulation. This is accomplished by successively loosening the soft tissues, grasping the bleeding vessels that are encountered, and forcing the jaw outward, dislocating the joint and then cutting away the capsule. The only point at which one encounters any difficulty is the attachment of the styloid process, but with a little care and manipulation this can be loosened readily.

It is wise to grasp the facial artery and vein at the point at which they cross the lower jaw before cutting these vessels, because in this way the wound may be kept practically free from blood. A drain is inserted in the posterior and anterior angles of the wound. The mucous membrane is first sutured and then the skin is sutured up to the point of drainage.

In case any of the surrounding tissues have become involved these should be removed freely, but it is doubtful whether much benefit can come in these cases from an operation if the disease has advanced to the point of invasion of surrounding tissues.

CARCINOMA OF THE LOWER JAW

Carcinoma of the epithelial structures of the mouth frequently invades the lower jaw. Usually cases which have advanced to this stage are practically hopeless, still it is proper to attempt the cure of some by employing the treatment which has just been described in connection with sarcoma of the lower jaw.

ALVEOLAR ABSCESS

This affection is so simple that it seems scarcely necessary to describe its treatment, which should consist in thorough disinfection of the cavity of the mouth, free incision of the abscess, thorough irrigation of the mouth after incision at intervals of one hour at first and less frequently later. Should the incision show a tendency to close a folded piece of rubber tissue may be inserted to keep the wound open, and thus facilitate drainage and healing from the bottom.

OSTEOMYELITIS OF THE LOWER JAW

Following severe infectious diseases, or severe infection from the root of a tooth, there is frequently a destruction of a portion or the entire lower jaw, due to osteomyelitis. Occasionally this disease also follows a compound fracture of the lower jaw. It is accompanied by severe pain, much edema, a high temperature and frequently by severe chills.

Technique in acute cases. When seen in the acute stage a free incision should be made through all the tissues, including the periosteum down to the bone. This will relieve the tension and produce drainage by directing the lymph stream away from the infected area. This will reduce the necrosis of bone tissue to a minimum. In many instances almost no sequestration will follow, as the bone seems to have the power of regenerating without destruction, while in cases in which the periosteum has not been incised large portions of the bone will be exfoliated in the form of sequestra.

In later cases in which the jaw bone has already been destroyed by the infection it is a grave error to remove the dead bone at once. In these the periosteum should also be laid open and the dead maxilla should be left in place to act as an irritant to the formation of an involucrum, and also to take the place of a mold over which the involucrum can be formed without unnecessary and unsightly deformity.

This treatment will be followed by the formation of a nearly perfect maxilla; while neglecting to incise the periosteum, or removing the dead bone at once, will be equally certain to produce results which are cosmetically and functionally bad in proportion to the extent of the disease.

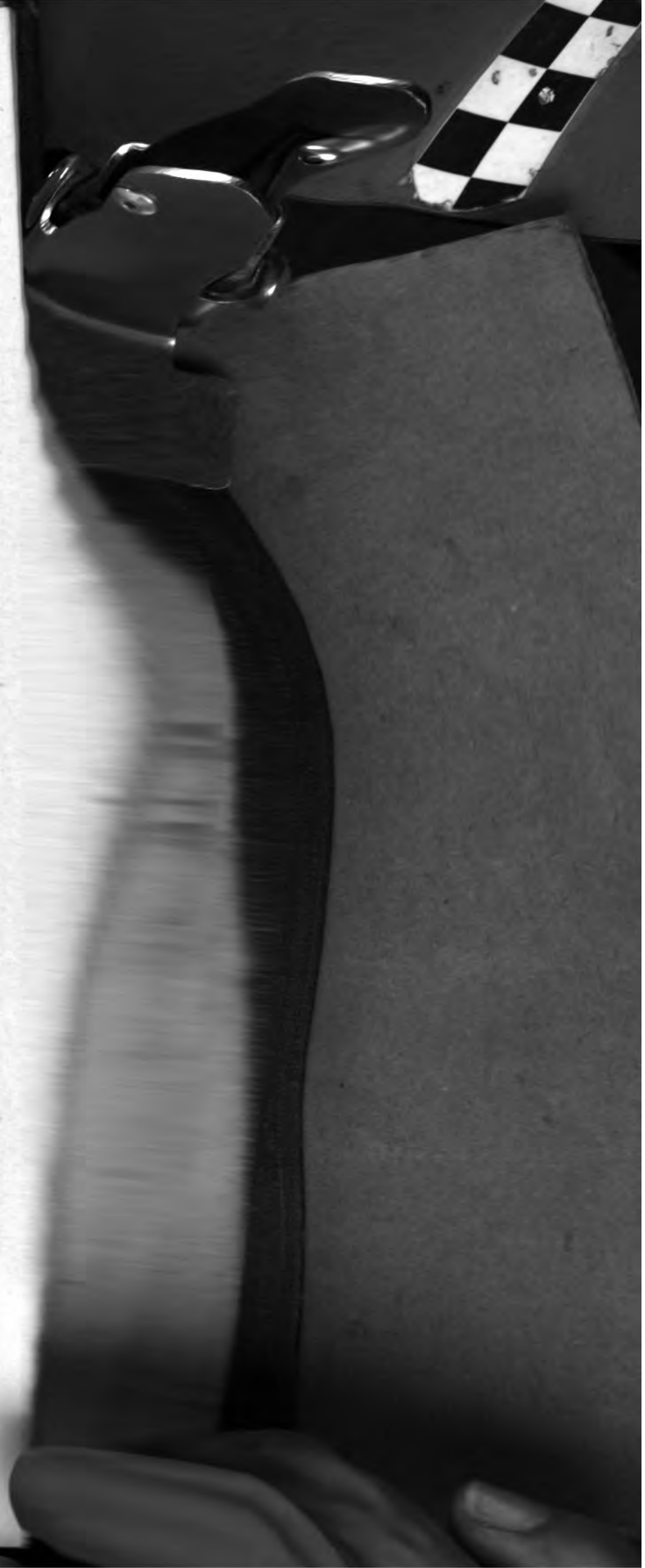
Technique in chronic cases. In old, neglected cases and in those which were not treated surgically at all during the acute stage, or treated too late, or in which the periosteum had been properly incised during the acute stage and in which an involucrum has improperly formed, the sequestrum causes continuous discharge of pus through one or more fistulæ. In all these the sequestrum should be exposed.

It is usually necessary to cut away some of the involucrum here or there in order to remove all of the necrosed bone. This should be done carefully in order not to fracture the involucrum. The space should be temporarily tamponed with gauze for two or three weeks; the skin should be carefully sutured in order to reduce the deformity to a minimum. After the gauze has been removed it is well to fill the space it occupied with Beck's bismuth paste, consisting of one part of subnitrate of bismuth and two parts of yellow vaseline. It is important not to inject this with much force, and the injection should be repeated once or twice a week until the cavity is closed.

PHOSPHORUS POISONING

In persons working in badly-ventilated factories wherein phosphorus is employed in various manufactures, a necrosis of the jaw occasionally occurs.

The treatment must consist in at once permanently changing the patient's



employment, directing his diet and his general hygiene and in treating the local condition the same as acute osteomyelitis.

ANKYLOSIS OF THE JAW

In complete ankylosis of the lower jaw the same operation is indicated as in ankylosis of other joints, which is described in another chapter.

In partial ankylosis the jaw should be mobilized under ether anesthesia and cork posts should be placed between the teeth on either side, with the mouth opened to the greatest possible degree in any given case. The patient should be kept fairly free from pain by the hypodermic use of morphine for at least a week while the mouth is being held open in this manner. Then the posts may be removed and somewhat smaller ones put in their place and worn regularly during the night, while during the daytime the patient may exercise the jaw. It may be necessary to repeat the mobilization under anesthesia several times at intervals of several weeks.

The treatment should be continued for a number of months.

The mouth should be kept covered with several layers of gauze while it is being held open by the posts in order to prevent harm from inspiration of dust or cold air.

Even after the patient has apparently completely recovered it is well to wear the posts between the teeth at least for one night each month to prevent recurrence.

EXCISION OF THE UPPER JAW

The method introduced by Kocher seems most satisfactory. We have practised it in many cases. It can be done most easily by first ligating the common carotid artery, temporarily, or by ligating the external carotid artery, either temporarily or permanently. If the temporary ligation is employed this is removed after the operation upon the jaw has been completed, the space carefully tamponed with gauze, and the patient placed in the sitting posture.

If the operation is performed without preliminary ligation the patient should have his head elevated throughout the operation by using the exaggerated inverted Trendelenburg position. A few times we have performed the operation rapidly in elderly persons, in whom preliminary ligation seemed contra-indicated because of the presence of marked arterio-sclerosis, with the patient in Rose's position with the head dependent beyond the end of the table, but the plan of operating with the head elevated seems much more satisfactory.

Technique. An incision is made in a vertical direction through the middle of the upper lip, it then follows the base of the nose up to the edge of the orbit, then outwards to the junction of the malar and frontal bones. The entire flap is reflected outwards and then the jaw is cut away with heavy bone-cutting forceps. The bleeding is controlled by pressure with gauze pads.

This operation is indicated only for the removal of malignant growths, hence it is wise to apply large cautery irons heated to red-heat to all of the raw surfaces. This will destroy any remaining portions of diseased tissue and will definitely stop hemorrhage. The space is then carefully tamponed, preferably with formidine gauze, and the skin-flap is carefully sutured in place throughout.

If indicated by the condition of the malignant growth the malar bone may be removed in part or entirely. If its orbital plate is removed it is well to remove the eye also.

The cosmetic result following this operation is relatively very satisfactory.

EXCISION OF THE PAROTID GLAND

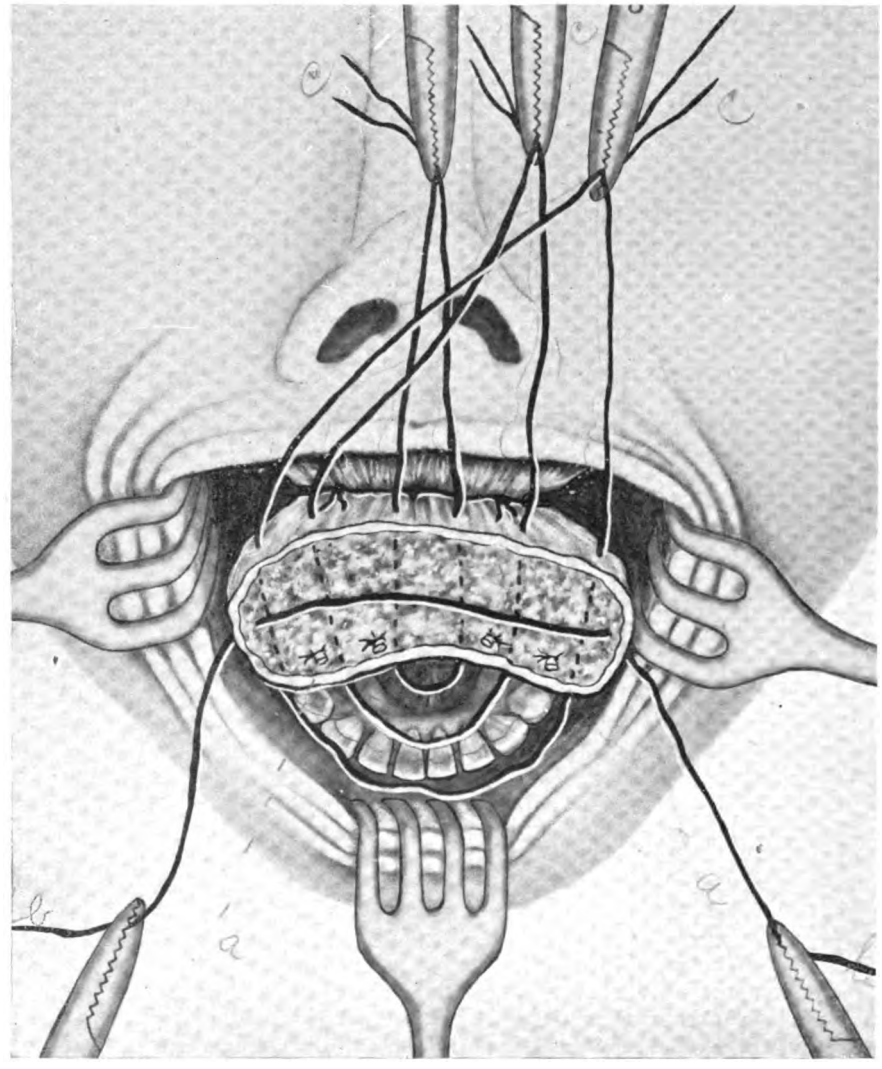
The removal of a portion of this gland is most frequently indicated in connection with the removal of tuberculous lymph glands of the neck. Its total removal is most commonly required for enchondroma. It is important in these cases to make a perfectly clean dissection, because if any portion of the tumor remains it is likely to recur in the form of sarcoma which can only rarely be permanently cured by a secondary operation. On the other hand, if the entire gland, together with its capsule, has been enucleated fairly early at the primary operation a permanent cure may be expected. The dangers of the operation are unimportant and will be discussed in connection with the operation for the removal of tuberculous glands of the neck.

EXCISION OF THE TONGUE

Carcinoma. Carcinoma of the tongue is not very uncommon and fortunately it is frequently amenable to surgical treatment, the prognosis being favorable in quite a considerable proportion of cases. If the portion involved is confined to the anterior half its removal is quite simple. The tongue is drawn out of the mouth, is transfixed at its base with a needle armed with a strong, double-silk suture; the tongue is tied in halves, considerable force being used in order to prevent the possibility of hemorrhage during the operation. A second, strong, silk suture is passed through the tongue just above the insertion of the first; with this the tongue is drawn forward. Then the diseased portion is cut away, leaving just enough beyond the silk ligature to permit the suturing of the two halves of the tongue in the median line. Upon inspecting this surface the blood vessels on the lower surface near the median line can readily be discovered. These are caught in hemostatic forceps and ligated separately. A row of sutures is then applied, bringing the two halves of the cut edge of the tongue in accurate apposition. These sutures are carefully tied and then the silk sutures are cut. The second silk suture which was applied is left in place for twenty-four or forty-eight hours in order to prevent the tongue from falling back into the pharynx. This accident happens very rarely, but when it does occur it is very troublesome unless some provision is made for holding it forward.

Glandular invasion. The submaxillary lymphatic glands and the cervical glands in front of the deep jugular vein are most likely to be involved secondarily in this condition, and if the disease is at all advanced it is wise to make an incision on each side and remove these glands, even though it may not be possible to palpate them through the skin. If the disease extends to the posterior portion of the tongue, either on one or both sides, it is best to make a temporary ligation of the external carotid artery before beginning the operation. This may be accomplished most readily by laying bare the artery at its origin on each side and applying a pair of clamps which have been especially constructed for this purpose. These clamps should not be sufficiently strong to cause any injury to the vessel, but just strong enough to prevent the passage of blood through it. The jaws of the instrument should be covered with rubber tubing to prevent the crushing of the vessel walls. The operation is thus rendered practically bloodless and can be accomplished with great thoroughness. The larger vessels should be caught in hemostatic forceps and ligated separately and then the stump which is left should be carefully closed by means of a sufficient number of sutures to prevent oozing. After the entire surface has been carefully covered the forceps are loosened first on one side and then on the other. In case hemorrhage occurs they can be compressed again and the bleeding controlled by the further application of sutures.

Complications. With this location of the growth there is still greater likelihood of invasion of the cervical and the submaxillary lymphatic glands, and



EXCISION OF THE TONGUE.

This plate shows the base of the tongue compressed by two strong silk ligatures which have been applied by passing a needle armed with a double ligature through the center of the tongue and tying in halves. These ligatures are removed after the diseased portion of the tongue has been cut and the vessels at (aa) have been separately ligated and the sutures (bb) and (cc) have been inserted.

When the temporary ligatures are cut traction is made upon the suture (bb), which will bring the lateral flaps into apposition. Then the sutures (cc) are tied and then (bb) the mucous membrane is closed by a continuous cat-gut suture.

in such instances their removal is always indicated, although it may not be possible to palpate them through the skin. In case the floor of the mouth is involved together with the tongue, the same preliminary compression of the

external carotid should be made, but in order to make a complete removal of the tissues it is wise to split the lip and the lower jaw through the middle down to a point just above the thyroid cartilage, to insert retractors in each segment of the jaw, and to open the entire space by careful continuous dissection. In this way the entire floor of the mouth and the base of the tongue may be perfectly exposed. The larger blood vessels are caught and ligated successively.

The excision of the tongue is performed as described above and if there is any mucous membrane left after the entire growth has been freely excised this is utilized for the purpose of lining the floor of the mouth. After this operation the forceps upon the arteries should be loosened before the jaws are united in order that all of the hemorrhage may be carefully controlled. After this has been accomplished the two halves of the jaws are united by means of chromicized catgut sutures. The floor of the mouth is drained through the lower end of the incision and the remaining portion of the wound is carefully closed.

This method provides a very perfect exposure of the field of operation, but it is, of course, very much more severe than the operations which have just been described, and we believe that it is indicated only in cases in which there is involvement of the floor of the mouth.

RANULA

In operating for the relief of ranula the object to be attained is either to establish a new communication between some portion of the ducts of the sublingual glands involved and the cavity of the mouth, or the complete removal of the entire gland. The simplest method by which to re-establish a connection between the ducts of the gland and the cavity of the mouth is through the use of a seton. By applying a large-sized silk suture transversely across the ranula and tying this loosely so that it does not have a tendency to cut away the intervening portion of the mucous membrane, one may frequently secure the growth of epithelial cells in these openings through which the silk suture passes so that the lining of the duct and the cavity of the mouth become continuous. After this has occurred at both the point of entrance and exit of the suture a new suture may be introduced through the same openings and tied more tightly so that the intervening tissue may become absorbed slowly. The opening formed between the cavity of the ranula and the mouth will thus become continuously lined with mucous membrane and presently a permanent opening will be established. This, however, will not occur in every case and it may become necessary, later, to remove a considerable portion of the tissue between the cavity of the mouth and the ranula, to sponge this cavity dry, and to cauterize it either with the actual cautery or with strong carbolic acid, followed after a few minutes with strong alcohol, or by the use of some other caustic, and then by the application of a tampon of iodoform gauze to the cavity thus formed. In a number of cases none of these methods will succeed and then it may become necessary to dissect out the entire gland in order to prevent recurrence. Unless the ranula has been severely inflamed it is usually possible to find a line of cleavage and to peel out the mass in a manner very similar to the method described in the removal of a branchial cyst. It is necessary to drain this cavity because its communication with the cavity of the mouth is likely to prevent preliminary healing.

SUBLINGUAL CYSTS

Occasionally a dermoid cyst is found in the region of the hyoid bone which may be mistaken for a ranula. It may sometimes be differentiated from a

ranula by the presence within the cavity of some epidermal structures, such as hair or teeth. The diagnosis is usually not made until these structures are encountered because of the much greater frequency of the presence of an ordinary ranula.

It is, of course, very evident that nothing but the complete excision of this growth will accomplish anything desirable. There is usually a line of cleavage which can be followed and the growth peeled out with little difficulty, unless there has been a chronic inflammation causing extensive adhesions. It is necessary to take especial care in dissecting out this growth at the point of its attachment to the hyoid bone, because it is at this point that one is likely to leave a small portion which will give rise to a recurrence.

EXCISION OF THE TONSILS

Complications. In this climate a large proportion of children and young adults suffer from the presence of hypertrophied tonsils, very commonly complicated by adenoids in the post-nasal space. This condition is exceedingly harmful, because it prevents the patient from normally performing the functions of respiration. The amount of air permitted to enter the lungs with each inspiration is greatly reduced unless the mouth be kept open, and in that case the patient suffers from the inhalation of impurities otherwise removed from the air by its passage through the nostrils, and by inhaling air which has not been modified either in temperature or moisture.

In many children there is a marked contraction of the chest due to this condition, and although the obstruction may later be removed the lung capacity can scarcely be fully attained because of the deformity which already exists.

Avenues of infection. The tonsils and post-nasal adenoids are also very likely to become infected with various pathogenic micro-organisms, the most common acute forms being those from ordinary pus microbes, the diphtheria bacilli, the micro-organisms of influenza and the pneumonia diplococcus, while a large proportion of these patients suffer from infection with tubercle bacilli. In this way the patient constantly carries about a dangerous septic focus. In many of these cases the infection from the tonsils and adenoids extends into the Eustachian tubes and gives rise to deafness, or it advances into the middle ear through the Eustachian tube, producing suppurative inflammation of this cavity, which may further result in an infection of the mastoid cells. It is not uncommon, moreover, for the infection to become acutely intensified, resulting in tonsillar abscess or an infection of the deep tissues of the neck.

There is scarcely another circumscribed area in the body from which so many secondary infections proceed as from the tonsil. It is one of the most common sources of cryptogenetic infection, and is frequently responsible for acute osteomyelitis. So long as this organ is normal there can be no doubt but that its lymphatic structure enables it to destroy a great number of pathogenic micro-organisms, but after it has once become diseased and filled with these micro-organisms their presence is a menace to the health of the entire body.

Technique. The indication for treatment is unquestionably plain in every case in which any of the circumstances that have been mentioned exist. The tonsil which causes the obstruction, and which contains the septic material, should be removed. This may be done very easily and safely by means of any one of a number of instruments which have been especially constructed for this purpose, or it can be done by grasping the tonsil with a pair of volsellum-forceps, and with the tonsil elevated, the blade of a thin sharp curved scissors is inserted at the edge of tonsil. The mucous membrane is cut around the tonsil. By inserting the scissors between the tonsil and the pillar and opening the jaws of the scissors wide, the tonsil is loosened, and can be drawn out so that with a wire snare the removal is readily accomplished.

Methods of hemostasis. Unless the tonsil is acutely inflamed, in which case the operation should be postponed, there is but slight danger from hemorrhage. If the organ is drawn too tightly into the cavity of the pharynx before it is cut off the tonsillar artery sometimes bleeds considerably. For the purpose of controlling this hemorrhage we have found the following mixture most useful: A teaspoonful of acetanilid, a tablespoonful of alcohol and about two ounces of water are mixed and used as a gargle. This usually stops the bleeding almost instantly. If this does not suffice pressure made with a sponge held at the end of a pair of forceps for a period of five minutes will usually be efficient. Should this also fail it is well to insert a catgut stitch about the base of the tonsil and to tie just firmly enough to stop the hemorrhage. There is an instrument constructed with two padded branches, one of which is inserted into the mouth and placed directly upon the bleeding tonsil, and the other at a point opposite on the outside of the neck. When this instrument is closed it makes a sufficient amount of pressure on the tonsil to stop the bleeding.

For the after-treatment the patient should be given some mild antiseptic gargle, which should be used mornings and evenings for a number of months following the operation, in order to improve the state of the mucous membrane of the pharynx.

The post-nasal adenoids. In these cases it is usually wise at the same time to curette away the post-nasal adenoids by means of a flat curette with the cutting edge at right angles to the handle and directed away from the handle. The instrument known in the market as the Gottstein curette is most useful for this purpose. The first finger of the left hand should be inserted above the uvula, and with the right hand the adenoids should be curetted away with a few quick motions. If the patient is anesthetized for this purpose he should be placed in the inverted position with the head dependent from the end of the table. After this has been done an ordinary small, semi-sharp curette should be introduced through the nostril, and with the finger still above the uvula to guide the spoon, the slight remnants of the adenoids which have not been removed with the flat curette may be carefully scraped away. Then a piece of dry gauze, doubled upon itself about two times, is introduced on the end of the finger, and with this the entire space is thoroughly rubbed, so as to remove any small portions that may still be present.

Breathing exercises. It is important that all patients who have suffered from the presence of hypertrophied tonsils and adenoids should be given careful instruction in breathing exercises. They should be taught to inhale fully through the nose, with the lips closed, so as to expand the chest to its fullest extent, being sure to make use of the diaphragm in this exercise. They should then force out the air—resisting with the lips—or, better still, they should blow through a small tube, with an opening about two millimeters in diameter, until the lungs have been emptied as much as possible. This exercise should be repeated about twenty times every morning and evening. It is remarkable how greatly these patients are benefited by this simple exercise.

Methods of holding the patient. Concerning the operation of tonsillotomy, we wish to emphasize the fact that it is greatly facilitated by having the patient's head held perfectly firm between the hands and against the chest of an assistant, if the patient is not under the influence of an anesthetic. It is wise in this case to have the patient drop his arms to his sides and then wind an ordinary bed sheet around his shoulders several times, so that he cannot interfere in the operation. An adult not under the influence of an anesthetic should be seated in a firm chair, an assistant should stand behind him, place one hand on each side of his head and force the same backward against his chest, so that the latter is held firmly on three sides. Children are best held by seating them in the lap of an assistant, who takes their limbs between his knees and holds the child in the manner described for performing intubation.

In using the tenaculum forceps and scissors, or scalpel, it is necessary to apply a gag between the teeth of the patient. This is also necessary in the use of some tonsillotomes, while with others it is possible to operate without because the tonsillotome itself prevents the teeth from closing.

TUMORS OF THE LIP

Angioma. This is the most common of all tumors in the lips of children. The growth appears as a little purple mark usually not larger than the head of a pin. This will increase in size in time until it may involve the entire lip. Later, it may extend over the face so that quite a portion thereof may be involved. After attaining some development this growth is likely to vary in size with differences in the temperature of the air in which the patient exists. While out of doors in the cold it will decrease so that it can scarcely be noticed, but when the patient is in a warm room it may increase so as to be quite troublesome.

Angioma of the skin in this vicinity, as in every other, should be removed at once as soon as the diagnosis is made, because its removal is a very simple matter in the early part of its development, while later on it may involve the production of a considerable deformity. So long as the growth is very small, not larger, for instance, than one or two millimeters in diameter, a simple puncture with a needle heated to white heat, or with the fine knife of the electro-cautery, or the fine point of a Paquelin cautery, will suffice to destroy an angioma permanently. If the growth has developed to a larger size it is best to excise it and to suture the wound so that the scar will be in the least offensive position.

Wyeth method of treatment. Recently Wyeth has introduced a new treatment which is especially valuable in cases of nevus in which the tumor has advanced so far in its development that its removal would result in a marked deformity, or in which the operation would have to be so extensive as to endanger the patient's life. In these cases a large metal syringe is filled with boiling water, which is injected directly into the angioma through a hypodermic needle about the size of an ordinary darning needle. As soon as the surface of the tumor begins to look white the injection is stopped. We have never injected more than four ounces at one sitting, but in case the tumor is large we think the amount might be exceeded with safety. Where the tumor is large we have found it necessary to anesthetize the patient.

The injected area becomes hard and somewhat swollen directly after the injection, but within a week absorption begins, which continues for several weeks. The procedure may have to be repeated several times. It is best to wait until the irritation has entirely subsided after one operation, before it is repeated.

Several times when patients have come from a distance we have sent them home with directions to return after several months for further treatment. In some of these cases the cure was complete when they returned, making further treatment unnecessary. This experience has caused us to lengthen the interval between treatments. The method has great value in a class of cases in which excision could accomplish little or nothing.

Epithelioma. Epithelioma of the lip occurs most commonly in the lower lip in the male. Its removal is indicated at the time when it is first noticed. The removal should always be extensive, at least half an inch of perfectly healthy tissue being excised in every direction. The incision should be at right angles to the edge of the lip and there should be a transverse incision joining the two verticals. All of these incisions should extend entirely through the lip. The transverse cut should extend beyond the vertical to about one-fourth the distance between the two vertical incisions, so that there is a flap

on each side which can be brought to meet its fellow and then the transverse incision can be sutured to the lower edge of these flaps. A very considerable amount of the lip may be removed in this manner without leaving any deformity to speak of. If the entire lower lip is to be removed the defect should be closed by means of a plastic operation. The importance of the square in place of the V-shaped excision has not been fully appreciated by many surgeons but it is perfectly clear that this doubles the distance of the edge of the lateral incision from the edge of the malignant growth without increasing the difficulty of closure or the post-operative deformity. This can be readily illustrated by drawing a square and then a V within this square so that the upper ends touch the upper corners and the point the middle of the lower side.

In epithelioma of the lip the submaxillary lympathic glands and the cervical glands lying anteriorly to the sterno-cleido-mastoid muscle, and externally to the deep jugular vein, are the ones which are most likely to be involved. If the epithelioma is at all advanced these glands should always be exposed and removed.

Of late we have subjected all of these patients to prophylactic X-ray treatment after the operation. Whether this will prove a proper course to pursue must be determined by further experience.

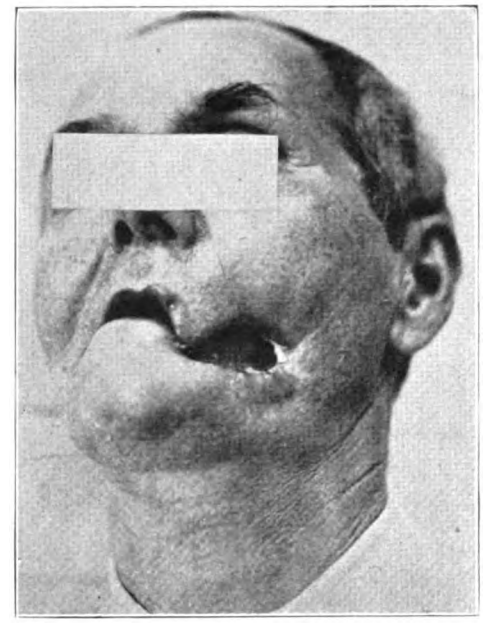
With a thorough operation performed reasonably early the prognosis is very good.

EPITHELIOMA OF THE FACE

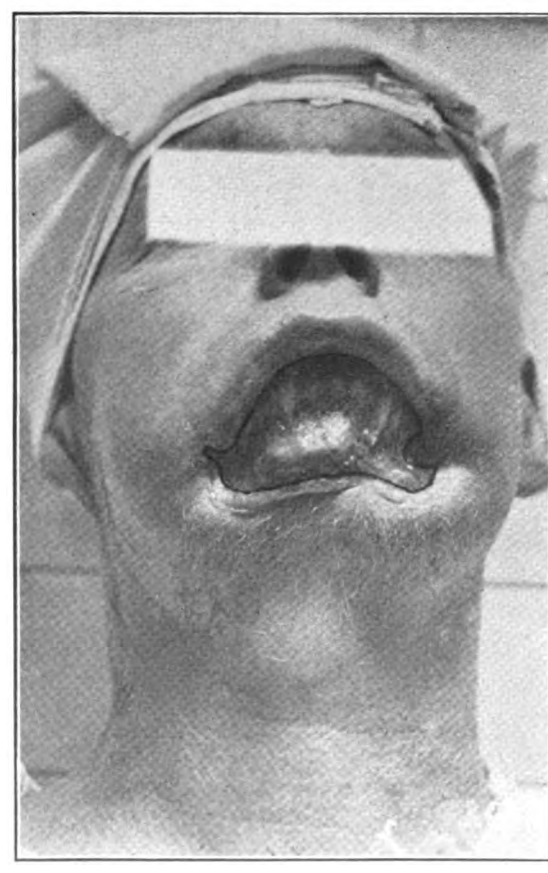
What has been said regarding epithelioma of the lip applies to epithelioma of any portion of the face. The excision should be done as early as possible.

Prickle Cell Epithelioma of the Cheek. Excised with the Electric Cautery and Base Cauterized with Hot Soldering Irons.

It should be very liberal and the defect caused should be covered by means of a plastic operation so that the resulting scars will interfere as little as possible



APPEARANCE TWO MONTHS AFTER EXCISING TUMOR. PLASTIC OPERATION LATER PERFORMED WITH TRIANGULAR FLAP FROM CHEEK, WITH EXCELLENT RESULT.



EXTENSIVE SQUAMOUS CARCINOMA OF LOWER LIP TREATED BY HOT CAUTERY IRONS AND INTENSIVE X-RAYS.

with the appearance of the patient. Especial care should be taken to avoid tension upon the eyelids because this will result in an irritation of the conjunctiva, which may lead to serious trouble. By transversely suturing wounds in the vicinity of the eyelids tension upon them may usually be avoided.

During the past ten years we have subjected a number of these patients suffering from epithelioma to X-ray treatment before operation, and have found that perfect recovery, without operation, as the result of the X-ray treatment is not at all uncommon, provided the epithelioma is superficial. In any case in which an epithelioma can be removed without causing great deformity, and especially without interference with the eyelids, we never use the X-ray at the present time until after the wide removal of the growth.

In farming communities in which lumpy-jawed cattle frequently exist, the farmers often suffer from ulceration upon the face due to infection by the ray fungus. These ulcers are more granular than epitheliomata, and show less tendency to undermining edges than syphilitic ulcers. These facts, together with the history of having handled cattle, makes the diagnosis of actinomycosis probable.

Such ulcers heal amost spontaneously upon the use of potassium iodide, 90 grains in half a pint of milk three times a day for three or four days, with interruptions of one week, as described in connection with the treatment of actinomycosis elsewhere.

PART III

SURGERY OF THE NECK

GENERAL CONSIDERATIONS

Lines of incision. It is important to bear in mind the natural lines on the surface of the neck in planning all surgical operations in this region, owing to the fact that unsightly scars are a source of distress to the patient and annoyance to the surgeon.

Incisions in the direction of the sterno-cleido-mastoid muscle are usually less evident from scars than those extending at an angle with this structure, or across it. This is true especially if the incision follows either the anterior or the posterior border of the muscle.

Incisions extending across the neck should be uniform on both sides if possible.

TRAUMATISM OF THE NECK

The most common serious traumatism is cut-throat inflicted by the patient himself during an attempt at suicide, or by some enemy.

In all of these cases careful hemostasis and adequate drainage are elements which must be provided for in order to obtain reasonably good results.

Until hemostatic forceps and ligatures can be applied the bleeding may be controlled by placing the ends of the fingers upon the bleeding vessels. Only rarely will it be possible to repair the wound in the side of a vessel. In case one deep jugular vein is entirely severed the patient will usually die from loss of blood before the surgeon arrives, but if it should ever happen that the surgeon appeared in time to find a patient still alive, with one deep jugular vein entirely cut and the other one nicked, an attempt to repair the injury in the second vessel would be proper.

When the pneumogastric nerve has been severed the patient is at once in a hopeless condition from hemorrhage from the deep jugular vein and the carotid artery before help can be obtained, consequently this condition need not be discussed at this point.

INJURY TO THE TRACHEA

When the trachea has been cut the patient usually coughs and struggles so violently, because of the fact that he fills his trachea with blood with every inspiration, that it is difficult to control the hemorrhage. It is, therefore, best to place the patient in the prone position, and if this is not possible, in the sitting posture, to make digital compression of the bleeding vessels and then to control the hemorrhage with hemostatic forceps. The trachea should then be carefully sutured with fine chromic catgut, then the vessels should be ligated.

An abundance of tubular and gauze drainage should be inserted, the cut muscles and fascia and the overlying skin should be sutured and a dressing applied.

It is seldom possible to unite the cut trachea so accurately that no infection takes place in the wound. If the wound in the trachea is irregular it may not be possible to close it. In that case an intubation tube should be inserted, the wound about this should be tamponed with gauze and the remainder of the operation carried out as described before.

CRUSHING INJURIES OF THE NECK

Crushing injuries may be so severe as to cause fractures of the larynx or the cartilages of the trachea.

In the event of dyspnea due to the collapse of these structures, or to the edema following the injury, this must be overcome either by the introduction of an intubation tube, which will at once provide a passage for the air and a splint for the support of the injured structures, or if the injured part cannot be reached in this manner, tracheotomy and the introduction of a tracheotomy tube should be employed.

The tube should be removed daily after the third day, to determine experimentally whether the tissues have recovered sufficiently to make it safe to discard the artificial aid. The patient must, however, be carefully and constantly watched for at least twenty-four hours after it seems safe to remove the tube permanently.

Many of these patients do much better if kept in a sitting posture. If tracheotomy is performed the canula should be kept covered with two to four thicknesses of moist gauze.

CYSTS OF THE NECK

Sebaceous cysts occur here as in all other portions of the body and must be treated by total excision, the same care being taken to prevent leaving any part of the lining membrane here as elsewhere.

Dermoid cysts occur in the same way as elsewhere, the many important changes that take place during fetal life in this region making their occurrence somewhat frequent, although these fetal remnants or inclusions in this region usually take the form of branchial cysts or thyroglossal cysts.

The treatment consists in careful, complete excision.

Aside from these cysts we encounter lymphangiomata, bursæ, hydrocele, blood cysts (aside from cysts of the thyroid gland) and hydatid cysts.

BRANCHIAL CYSTS

During the early development of the embryo there are four clefts on each side of the neck corresponding to the gills in fishes. These later become obliterated, but occasionally the layers do not unite perfectly and there are left portions of the epiblastic tisue which have not been destroyed and which later secrete a fatty substance which will accumulate in this defect and presently form what is known as a branchial cyst.

The cyst develops slowly, is located underneath the skin and superficial fascia, fluctuates upon palpation, and is not inflammatory in character.

The incision is advisably made over the cyst in the direction of some of the longer lines of the neck, and upon approaching the growth a point will be reached where there is a longer line of cleavage between the tissues. By separating the cyst from the surrounding tissues through this latter it

can be easily removed. The wound is closed in the customary manner and it heals kindly. By finding the natural line of cleavage one can remove the growth without any danger of injuring the deep jugular vein, in whose proximity it exists, and even if there has been an inflammatory condition which has resulted in adhesions to the deep jugular vein the growth may readily be removed by careful dissection without danger.

What has just been said may be applied to all the other cysts mentioned, with the exception of those of the thyroid gland, which will be considered later, and the hydatid cyst which is due to a parasite and which may occur between the layers of any of the structures of the neck. This latter form will be recognized by the fact that within a capsule of connective tissue there is a second cyst which is no part of the human body, but of the parasite. This will peel out spontaneously as soon as the connective tissue covering is open, for there is no connection between the two structures.

THYROGLOSSAL CYST

In some cases the thyroglossal duct has failed to become obliterated during fetal life and having a mucous lining it continues to secrete mucus, which may be emptied either through an opening at the external end of the duct opposite the prominence of the thyroid cartilage, or into the mouth through its opening at its inner end opposite the hyoid bone, or both ends may discharge this mucus, forming a thyroglossal fistula.

Again both ends may be closed and a thyroglossal cyst form. In either event the only treatment promising relief consists in the complete excision of every portion of the mucous lining.

This lining is extremely delicate and it is possible to make a complete dissection only if the very greatest care is exercised. This is true especially because the canal is frequently not straight and the cyst wall often forms irregular pockets. The dissection may be facilitated by injecting melted paraffin (melting point of 110° F.) into the sinus, permitting this to harden and then removing the cyst or sinus with its paraffin plug.

The outer opening is grasped with fine forceps and the skin surrounding the osteum is excised, together with the lining of the entire sinus or cyst, care being taken to remain outside of the cyst throughout the operation.

GOITRE

Until recently it has generally been supposed that in this country patients suffering from goitre rarely afford a characteristic history such as they give in portions of Switzerland, France or Wales, where certain regions seem to furnish a very large proportion of patients, while other regions are relatively free from them.

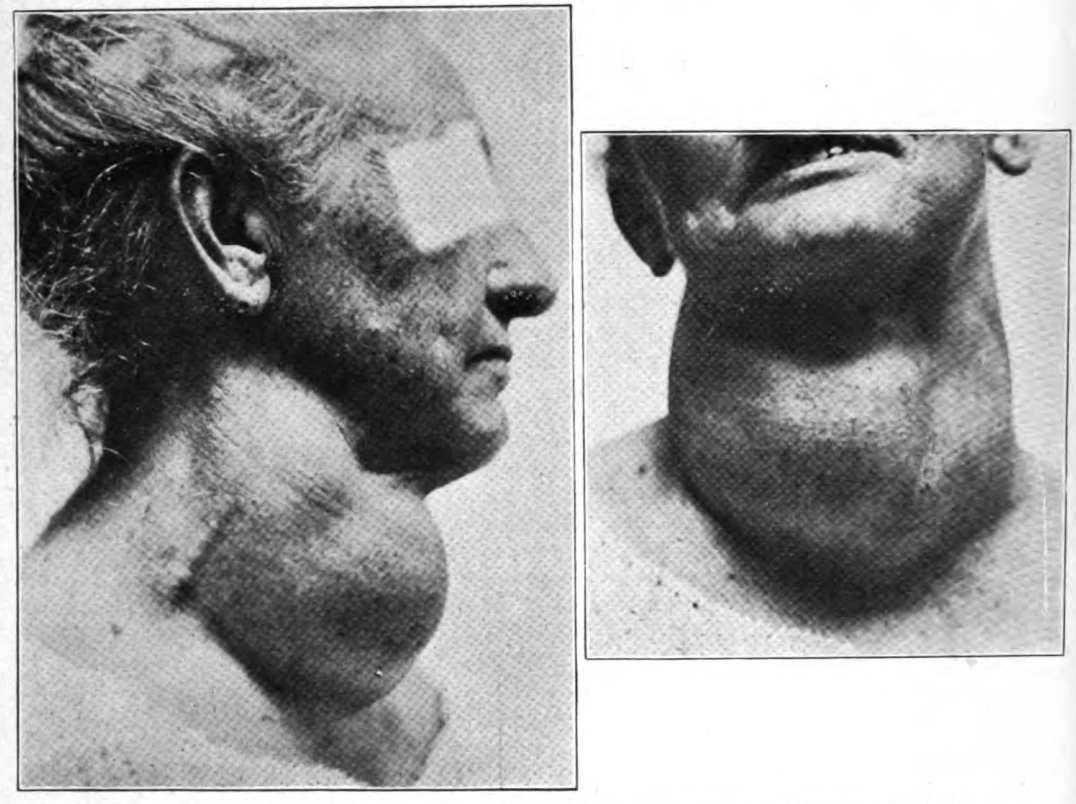
Apparent cause. Since goitre has been studied more carefully in this country many regions have been found where this disease abounds and recently a number of farms have been investigated each supplied by a single well which has seemed to cause the appearance of goitre, especially in the younger members of the family, from drinking the water. Families having been quite free from this disease have taken up their homes upon these farms, and within a year several members thereof have become afflicted, then changing their residence the children who were born later remained free from the disease.

The investigations described in the *U. S. Public Health Reports,* April 14, 1914, have given such clear and positive results that it seems proper to repeat here the most striking points, because a knowledge of these facts will aid

the surgeon in instituting prophylactic measures as well as in properly directing the after-treatment. These investigations show that goitre occurs in regions in which the drinking water is soft, as well as in those in which it is hard, and also that there is no clinical evidence that dissolved salts cause goitre.

Goitrous water may be radio-active and it may contain much carbon dioxide. Goitre may be due to much iodine in drinking water.

There seems to be a direct relationship between the affection and the degree of bacterial contamination of water supply.



DIFFUSE COLLOID ADENOMA OF THE THYROID GLAND. TREATMENT—EXCISION OF ¾ OF ALL LOBES.

Experimentally goitre was produced in man by water from a goitrous stream. By giving the same water boiled, goitre was not produced.

MacCorrison gives the following conclusions:

1. Goitre can be produced in a few weeks by suspended matter separated by filtrations from goitre-producing waters.
2. Thyroid enlargement cannot be so produced when the sediment is boiled.
3. Goitre so produced cannot be due to mineral matter but is due to a living organism.
4. While it cannot be positively stated that a Berkfelt filter removes the cause of goitre, water so filtered cannot produce goitre within fifty-six days, which was the period of the experiment.

These conclusions are quite in keeping with those of Bircher who made

extensive experiments with the use of goitre water in rats. He demonstrated the following facts:

1. That centrifugalization renders the pathogenic water innocuous.
2. That addition of chemicals, like hydrogen peroxide, renders the pathogenic water innocuous.
3. That dialysis removes the goitre-producing substance from the water.
4. That substances separated by the membrane of the dialysis can produce the disease.

As a result of Bircher's experiments the city of Rapperswyl, in Switzerland, in which 70 per cent. of all natives had goitres, was freed completely from endemic goitre by taking the water supply from a region in which there is only granite rock, while it was previously taken from a region which had been covered by the ocean in former ages. Whether the heat (which melted the sand into granite) caused this difference it is difficult to say.

One of the instances quoted frequently shows the influence of this infected water so clearly that it seems wise to repeat it here.

Example. Two private schools located only a few miles from each other obtained their drinking water from two different springs. Both schools obtained their pupils from many distant points. The pupils of one of these schools developed goitre regularly while the pupils of the other school as regularly remained free from goitre. When the water supply of the first school was changed the pupils also remained free from goitre while attending this institution.

Kocher likewise claims that if water is boiled it loses thereby its infectious character and becomes quite as harmless as that from any pure source. Whether this is due to the precipitation of lime salts contained in the water, or to some micro-organisms, has not yet been determined.

It seems, however, imperative that families in which several goitres have occurred be advised to use water for drinking purposes from an entirely different source of supply, or else that they invariably boil all drinking water from the well which is supposed to have caused the goitres already developed.

Characteristics. The enlargement of the thyroid gland more commonly appears about the age of puberty than at any other time. It also occurs during gestation in quite a number of patients. It happens much more frequently in this country in females than in males. It may affect any one or two, or all of the lobes of the thyroid gland, although the right lobe is most frequently the largest. When the middle lobe is involved there is frequently an enlargement extending down behind the upper end of the sternum, causing quite severe pressure upon the anterior surface of the trachea. The patient may seek relief because of the deformity caused by the presence of the tumor; because of its weight on the neck; or because of the obstruction in the trachea produced by pressure from a lobe of this gland. The enlargement may be due to an increase in the parenchyma of the gland, or one of the lobules may be distended with gelatinous or serous fluid giving rise to the formation of a cyst, or there may be a fibrous degeneration of a portion of the gland or the development of a fibrous tumor, or, especially in patients advanced in age, there may develop a malignant growth, either carcinoma, sarcoma, endothelioma or angioma. The enlargement may also be due to a simple infection, with its skin edema.

Diagnosis. The diagnosis of a tumor of the thyroid is simple because of the form and location of this gland; also from the fact that if the patient swallows the gland rises with the larynx, being firmly attached to the trachea. An enlargement due to an inflammatory condition can be easily recognized because of the symptoms accompanying inflammatory conditions in any part

of the body. Malignant growths are characterized by an induration of the tissues, which is not present in a benign growth of the thyroid gland. The age, and, usually, a rapid development of cachexia, are important conditions to be considered in making this differential diagnosis.

Hygiene and internal medication. In young girls the glandular enlargement commonly subsides if general hygienic measures are employed. This may be somewhat facilitated by administering, three times a day, tablets containing five grains each of the desiccated thyroid gland of sheep, the doses being somewhat varied according to the condition of the patient. General tonics are indicated in these cases. In older patients the absorption of these growths is sometimes further facilitated by the hypodermic injection of from sixty to one hundred and twenty drops of a five per cent. solution of carbolic acid in water, directly into the enlarged lobe. This should be done once each week at first and less frequently later on. The same hygienic and tonic measures should be employed as in younger patients.

Indications for surgical treatment. Where the goitre increases in size notwithstanding the hygienic, dietetic, medicinal and injection treatment just named surgical removal of the gland may be indicated, provided the patient suffers because of the incident pressure, from pain, dyspnea, interference with the recurrent laryngeal nerve or in case the weight of the part becomes burdensome or the deformity repulsive.

EXOPHTHALMIC GOITRE

From the standpoint of the surgeon the diagnosis of exophthalmic goitre, in cases coming properly under surgical treatment, is not a difficult matter because no case properly belongs in this class unless treatment with rest, hygiene, diet and internal medication has either failed altogether or has failed to relieve the patient permanently of the disease.

As early as 1786 Parry gave a clear description of the symptoms of this disease. This was repeated by Graves in 1835 and five years later with great clearness by Von Basedow, and since then innumerable times by hundreds of clinicians.

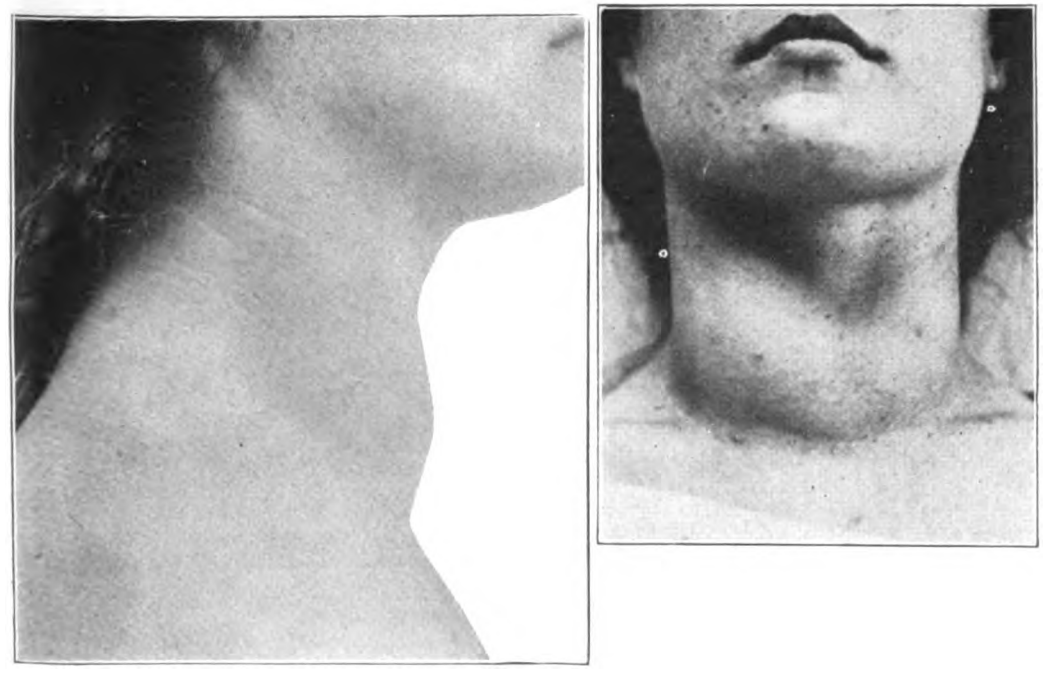
The following may serve as a short, concise summary of the symptomatology.

Summary of characteristic symptoms. 1. Exophthalmos. 2. Tachycardia. 3. Tremor. 4. Muscular weakness. 5. Nervous excitability. 6. Vertigo. 7. Graef's signs (in directing the eye downward the lower margin of the upper eyelid does not follow the line of vision normally, but lags behind or follows in an irregular spastic manner). 8. Stellwag's sign (retraction of upper lid together with infrequent winking). 9. Paroxysmal dyspnea. 10. Intermittent vomiting without apparent exciting cause. 11. Intermittent diarrhea without apparent exciting cause. 12. Intermittent sweating without apparent exciting cause. 13. Intermittent mental depression without apparent exciting cause. 14. Psychic excitation increases the gravity of the condition. 15. Physical or mental fatigue increases the gravity of the condition. 16. The administration of thyroid extract increases the gravity of condition. 17. The administration of iodides increases the gravity of the condition. 18. In advanced cases there is practically always emaciation.

Any one, or any group, of these symptoms may be prominent early, while others, especially the goitre and the exophthalmos may be late in appearing, or may be developed to so slight an extent that they are only noticed after the examining physician's suspicion of the presence of the disease has been aroused by the prominence of some of the less common conditions. The one symptom of tachycardia, however, seems to be present in every case.

Blood analysis. Kocher has found some fairly uniform conditions in the blood examinations made in cases suffering from exophthalmic goitre, but they are also present in a number of other diseases. There seems to be lessened coagulability of the blood; the polyneutrophiles are decreased from 75 per cent. to 35 per cent., while the lymphocytes are increased from 25 per cent. to 75 per cent. in individual cases on the day before operation, while on the day after, the neutrophiles increased from 42 per cent. to 89.2 per cent., whereas the lymphocytes decreased from 48 per cent. to 2.7 per cent.

Kocher comes to the conclusion that there is an increase in lymphocytes and a decrease in neutrophiles before the operation and vice versa after opera-



EXOPHTHALMIC GOITRE IN A GIRL OF 21 YEARS. TUMOR PRESENT SINCE AGE OF 13 YEARS. SYMPTOMS PROGRESSED VERY RAPIDLY DURING THE PAST YEAR. OPERATION—EXCISION OF THE RIGHT, MEDIAN AND ⅔ OF THE LEFT, LOBES.

tion. He characterizes exophthalmic goitre as a hyperthyreosis with glandular hyperplasia, lymphocytosis and lymphatic disturbances of the gland.

The increase in lymphocytes, however, was more often relative than absolute; the total number of leucocytes being normal or rather low.

Value of early diagnosis. From the practical standpoint, however, it should be stated that the diagnosis is made in almost every case a long time before the surgeon is consulted. Indeed, until very recently, too long a period of time has intervened between the original diagnosis and the surgical treatment in many of these cases, and too much stress cannot be laid upon the importance of an early operation in all instances in which a permanent cure is not obtained by internal treatment pursued a reasonable length of time; provided, first, that the patient is not suffering from temporary exacerbation of the hyperthyroidism, and, second, that the disease has not existed sufficiently long to leave the circulation and the nervous system of the patient in an absolutely hopeless condition. Unless one recognizes the first of these contra-indications one will lose patients who could easily bear the strain of the operation were they not also compelled to bear the additional strain

of the temporary hyperthyroidism. This can be avoided by waiting until the temporary storm has subsided. In the vast majority of these cases one will find that such exacerbations have repeatedly occurred before, only to subside again under treatment with physical, mental and emotion-rest, proper diet and internal treatment. Of course, the patient each time emerges from such an attack in a worse condition than previously, consequently one shows better judgment by avoiding operations during an attack of acute hyperthyroidism.

This fact is most forcibly insisted upon by Kocher, Mayo and all other clinicians who have had a large experience in the surgical treatment of these cases, and is one that should be especially impressed on the family physician.

Youthful patients. It is well to bear in mind that especially in young girls, about the time of puberty or a little later, many goitres cause symptoms which will justify a diagnosis of incipient exophthalmic goitre. The tremor,

DIFFUSE TOXIC ADENOMA OF THE THYROID GLAND.

the muscular weakness, the nervous excitability, some tachycardia and many of the minor symptoms are often present. There may even be a very slight degree of exophthalmos, and still these patients will almost invariably recover without operation under physical, mental and emotional rest; a diet composed largely of milk, cooked vegetables and fruits; favorable hygienic surroundings; and absence of conditions which might cause nervous excitement.

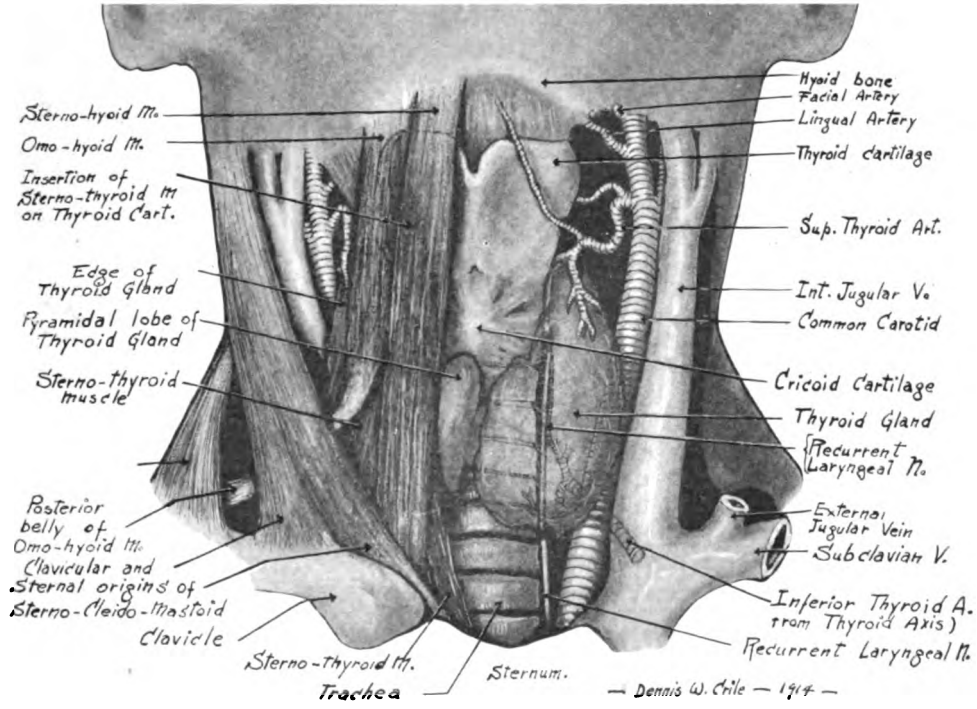
It is well to bear this in mind because it will prevent many unnecessary operations.

Although much attention has been given to the complications affecting the nervous, the circulatory and the digestive systems, because of their being directly dependent upon the disease, it must be remembered that exophthalmic goitre is not uncommonly complicated by diseases of any portion of the body. Even myxedema has been described as a complication by Simonds, Gooding, Faure and a few others, although such disease is plainly the result of a lack of physiological activity of the thyroid gland, while exophthalmic goitre is supposed to be due to a hyperthyroidism, according to Kocher, or to a toxin caused by an excessive amount of normal or abnormal thyroid secretion, according to Moebius, while Oswald and a few others think there is a thyroid insufficiency. To our minds the beautiful description of pathological findings by McCallum are convincing of the fact that there is indeed always a condition present which must result in hyperthyroidism, no mat-

ter what the exciting cause may be, and this we think is plainly borne out by the clinical picture.

In order to produce a clear idea of a reasonably safe operation in exophthalmic goitre it may be well to describe the various steps successively.

Pre-operative treatment. It is important to prepare those with a pulse 120 or over or with a pulse which lacks uniformity, by absolute rest in bed, mild sedatives, a meat-free but nourishing diet, quiet surroundings, absence of all psychic excitation, which according to the observations and animal experimentations of Crile is capable of producing hyperthyroidism by



THE THYROID GLAND AND ITS RELATIONS.

The structures are shown as though transparent, the muscles of the left side having been removed, showing the left lobe of the thyroid gland, with the recurrent laryngeal nerve and the inferior thyroid artery behind it.

a discharge, in some way either directly or indirectly, into circulation of an excessive amount of thyroid secretion, which in itself may cause death.

Four grains of hydrobromate of quinine, in capsules, given after meals three times daily, seems to be of some benefit in the preparatory treatment of these cases. A considerable proportion may improve so much under this treatment that an operation may become unnecessary.

Tepid baths and any other means of making the patient comfortable and contented are useful. If general anesthesia is employed this should be given so as to not excite the patient.

In order to prevent infection two precautions are important; first, the careful covering of the patient's hair, and second, guarding against infection from the mouth and nose. It is an easy matter for a patient to fill her own wound with infectious material from her mouth, or nose, if these are not under the careful supervision of some assistant who gives his entire attention to this matter. If the operation is performed under cocaine anesthesia

this protection can readily be accomplished by placing a dozen thicknesses of sterile gauze in the form of a roller bandage over the patient's mouth and nose and around the head. The patient will be able to breathe through this covering but the air expelled from the nose and mouth will be filtered on its way through these layers of gauze.

Anesthesia. The careless use of anesthetics in this operation is one of the greatest dangers, because of the slight margin of safety, and because of the poisonous effect of all anesthetics, except ether; also because of the fact that respiration is often interfered with to some extent by the manipulations of the operation, and because mucus is likely to accumulate in the larynx during the operation.

As a matter of choice whenever the patient is willing at the present time we invariably use *infiltration and regional analgesia in subtotal thyroidectomy.*

Of all operative procedures to which the employment of local anesthesia has been extended, in perhaps none are the results more gratifying to the surgeon and beneficial to the patient than in thyroidectomy. Especially is this true in the exophthalmic and toxic goiters where the administration of ether must of necessity increase the hazards of the operation. Moreover, local anesthesia seems to be especially suitable to that large majority of patients in whom the myocardium and the nervous system exhibit the effects of prolonged hyperthyroidism.

This method possesses the following distinct advantages: 1. The patient can at any time talk to the surgeon, thus abolishing the chance of injury to the recurrent laryngeal nerves. 2. The condition of the patient can be accurately determined at any given time. 3. With carefully prepared solutions, healing occurs by primary intention in 100 per cent. of cases. 4. Post-operative convalescence is distinctly improved, i. e., nausea and vomiting are eliminated. 5. Post-operative broncho-pneumonia, complicating, is almost unknown. 6. The incidence of post-operative hyperthyroidism appears to be diminished.

The Method in Detail. We have employed local anesthesia in the last 57 thyroidectomies at the Augustana Hospital and have been gratified with the results obtained. Prior to the adoption of this method ether anesthesia had been the routine in many surgical operations on the thyroid gland extending over the past thirty years.

The adult patient receives a preliminary hypodermic injection of morphia ¼ gr., combined with atropin sulphate gr. 1/100, two hours prior to the operation and a second hypodermic injection of morphin, gr. 1/200, one hour before the operation. He is placed on the operating table in a quiet side room and while the head and eyes are covered with a sterile towel is told that he will receive a local injection in the place of ether anesthesia. The skin of the neck, chin and suprastermal region is cleansed with alcohol and sterile towels arranged.

The solution is freshly prepared as follows:

Apothesine (Parke, Davis & Co.) ..... gm. 0.6 (gr. 7.5)
Sodium chloride ..... gm. 0.8 (gr. 12)
Aqua destillata, q. s. ad ..... 100 c. c.

After adding the apothesine and NaCl to the sterile distilled water the solution is slowly brought to boiling for several minutes to insure absolute sterility. The entire quantity of 3½ ounces may be accepted as the average amount to be injected although we have on numerous occasions employed twice this quantity of the solution in ½ per cent. strength without any immediate or subsequent ill effects being observed.

The sodium chloride is added with the definite view of approximating a physiological saline solution of the same osmotic tension as the blood, since local necrosis, irritation of the skin edges and delayed healing are known to follow the injection of distilled water in relatively large amounts.

Adrenalin solution (1 in 1000) minims 10 may be added after preliminary boiling and due to its vaso-constrictor action both prolongs and intensifies the degree of analgesia. It possesses, however, this distinct disadvantage: the intense ischemia of the operative field leads to a false sense of perfect hemostasis with possible subsequent hematoma formation. Furthermore, when using adrenalin in the solution, analgesia develops more slowly and it is desirable to wait thirty minutes before operating, while with the above solution as employed, anesthesia is complete within three to five minutes after injection. It lasts from one to two hours in the average patient.

Technique of Injection. The usual preparation completed, local anesthesia is effected by employing a combination of two different methods: (1) By the intradermal and subcutaneous injection of the apothesine solution along the proposed curved skin flap incision, i. e., the usual "Kocher collar incision" the method of infiltration analgesia. (2) By injecting the solution into and around the site of the nerve trunks supplying the operative field, regional analgesia or nerve blocking. The cervical plexus of nerves on each side of the neck is blocked by passing the long blunt needle on the base of the finger through the skin down to the anterior border of the sterno-cleido-mastoid muscle at about its mid portion where the large

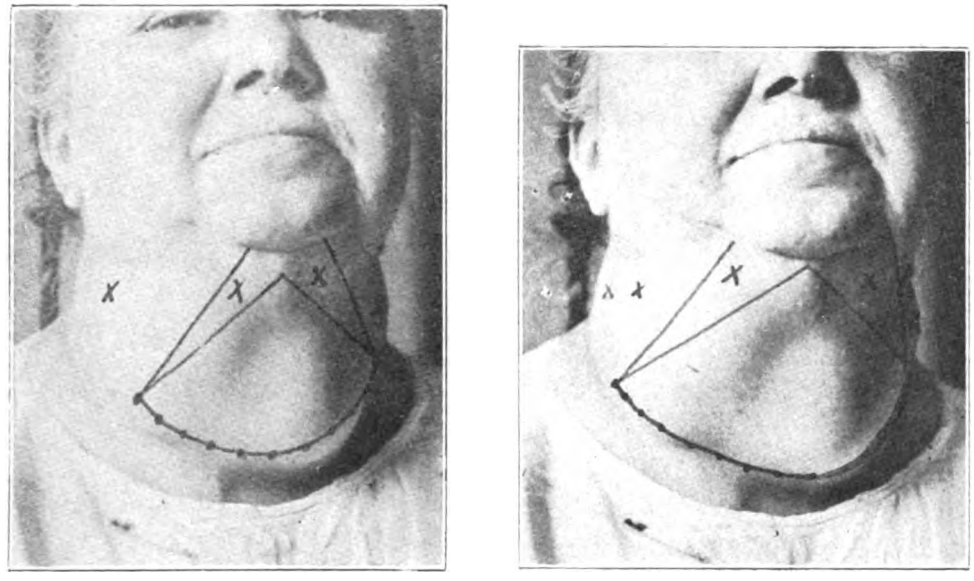


FIG. I.—Illustrating the sites of injection in local analgesia in thyroid surgery. The dotted line is the Kocher collar incision which is infiltrated intradermally and subcutanecusly. The points marked X represent the location of the nerves of the cervical plexus blocked by regional anesthesia at the middle portion of the anterior border of the sterno-mastoid muscles. Also two carotid pockets to be injected.

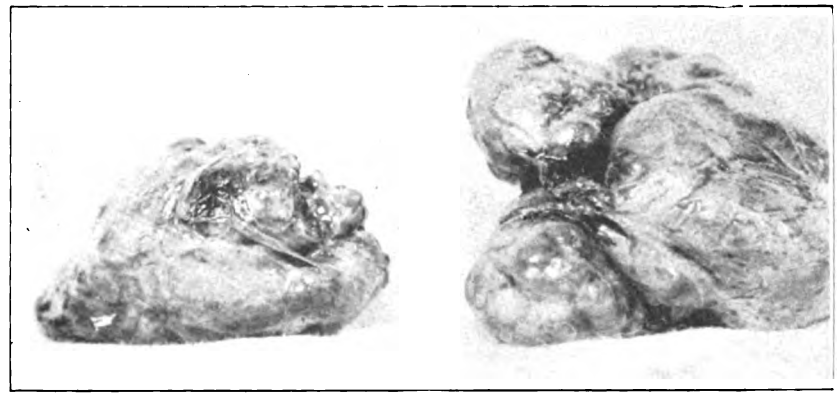


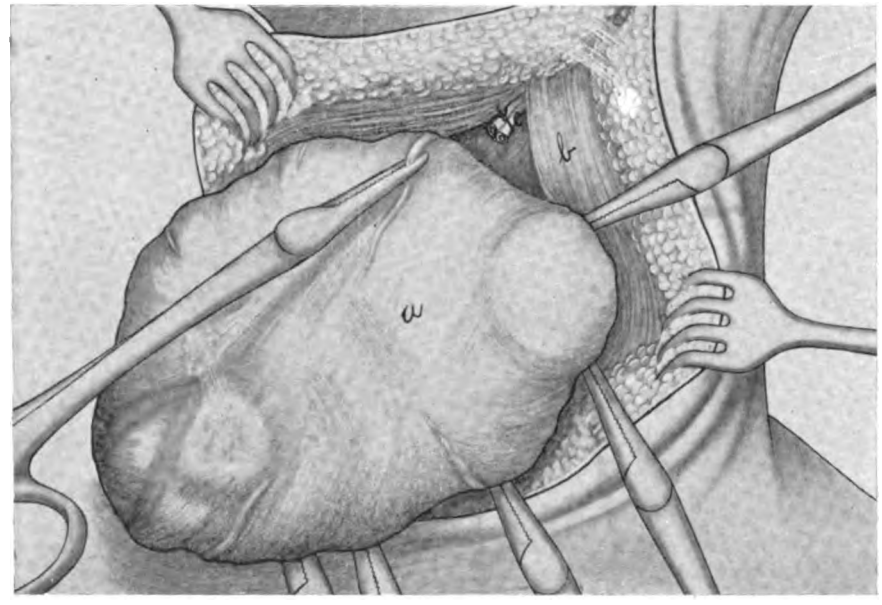
FIG. II.—Gland removed painlessly under local anesthesia.

[To face p. 160]

superficial cervical nerve (nervous cutaneous colli) passes transversely across the sterno-mastoid muscle to divide into upper and lower branches supplying the skin from the mandible to the supra-sternal region. In addition it is important to infiltrate the two pockets at the upper poles of the lateral lobes in the region of the carotid triangles. To insure complete blocking a relatively large amount of the solution must be injected in the sites designated in the accompanying illustration. Because tactile sensation may occasionally persist, although the loss of pain sensation is complete, we have employed the term analgesia in preference to anesthesia.

The operative field is now prepared with 3½% tincture of iodine, the sterile towels arranged and the head of the table elevated. Analgesia is complete within five minutes so that delay is not desirable as when using the adrenalin solution. Anesthesia persists for periods varying from one to two hours allowing far more than ample time for even the most difficult case. We have seldom found it necessary to make an additional injection of the solution after the operation was started.

It is well to bear in mind the fact that the patient usually experiences a transitory painless choking or sensation of suffocation when the lateral lobes are luxated or manipulations in enucleating the lobes occasions pressure on the trachea. Aside from this brief uncom-



THYROIDECTOMY.

Showing large incision with primary ligation of superior thyroid artery and vein at *c;* the retracted sterno-cleido-mastoid muscle at *b* and the dislocated gland *a*.

fortable sensation, the entire operative procedure is painless even in the largest type of goiters.

The advantages of this method over general anesthesia are obvious. Cases which could not withstand an operation under ether can have the advantage of surgical treatment at an earlier date. Post-operative convalescence is remarkably free from nausea, vomiting and pneumonia. And finally, the satisfaction derived by the surgeon, who is able at all times to converse with the patient and thus insure protection against injury to the recurrent laryngeal nerves, should suggest a universal adoption of local analgesia in thyroid surgery.

If one-fourth of a grain of morphia and one one-hundredth of a grain of atropia are administered hypodermically half an hour before the operation is begun, and the patient is then thoroughly anesthetized with ether by the drop method; and if then the head of the table is elevated so that the body lies at an angle of 45 degrees, the operation can be completed without the further administration of ether. This makes the use of ether perfectly safe, and the patient's pulse regularly improves during the operation. The jaw must, however, be held forward by a reliable assistant during the entire

operation in order not to permit the tongue to obstruct the respiration by falling back into the pharynx. In case this or any other form of general anesthesia is employed in this operation the post-operative hyperthyroidism can be greatly reduced if thorough gastric lavage is employed with water at 110° F. immediately at the conclusion of the operation, which washes away any ether and mucus which has been swallowed. An ordinary bath thermometer should be used to determine the heat.

Technique. The curved transverse symmetrical incision of Kocher is made with convexity downwards; its lowest portion being 2 cm. above the upper end of the sternum. The skin flap, together with the platysma, is reflected upward to a point just above the upper attachment of the sternothyroid muscles. These are now cut across at their upper end and reflected downward. This gives an excellent field of operation. It is now possible to grasp the superior thyroid vessels between two pairs of forceps and to cut and ligate both ends.

In the meantime the superficial vessels which have been encountered have all been grasped between two pairs of hemostatic forceps and have been cut and ligated.

Having severed the superior thyroid vessels on the side, of course, on which an enlargement is found or on which there are irregular nodules to which the disease has been attributed, it is an easy matter to dislocate the lobe forward. This brings into view the inferior thyroid vessels. These are then grasped between two pairs of hemostatic forceps, then cut and ligated.

At this point it is very important not to grasp the vessels too near their origin, especially on the right side, for fear of injuring the recurrent laryngeal nerve or the lower one of the parathyroid glands. Both of these structures are located between the thyroid gland and the trachea near this point, and both may easily be avoided if the above plan is followed.

The lobe is then dissected up, care being taken to leave the posterior portion of the capsule undisturbed and with it the recurrent laryngeal nerve and parathyroid gland. The isthmus is now lifted up and this exposes the inferior thyroid vessels of the other side. These should usually be treated precisely as those on the side which has just been finished, unless the disease is entirely confined to the one side. In most instances it is best to remove one entire lobe, with the exception of the posterior capsule. The isthmus and about the lower half of the other lobe should usually be removed, also without disturbing the posterior capsule. This applies only to cases whose margin of safety is sufficient to make so extensive an operation safe. In case of doubt one lobe only is removed at the first operation and if this seems too much one or two groups of vessels are ligated and the excision of the gland is made at a later time.

This disposes of both inferior thyroid arteries and veins as well as the superior vessels on one side. During the entire operation all manipulations are made with the greatest gentleness in order not to press contents of the gland into the circulation or into the wound for fear of causing acute hyperthyroidism.

At the same time great care is taken to prevent hemorrhage, because Kocher has pointed out the toxic effect of blood absorbed by the wound surfaces. For the same reason every precaution is taken to stop any oozing into the wound after the operation.

The muscles are then carefully sutured in place so as to reduce the deformity to a minimum. A small drain is inserted through the lowest point in the wound, or, better still, through a small opening 2 cm. below. The skin wound is closed with the greatest accuracy in order to prevent deformity.

There is practically always a sufficient amount of serum secreted to indicate the use of good drainage.

What has been said concerning the technique of thyroidectomy for the relief of exophthalmic goitre is true of the operation for simple goitre, with the one difference that the latter class of patients is usually in a much better general state of health. The greatest amount of danger in the former class comes from the effect the hyperthyroidism, characterizing the disease, has already had upon the tissues of the patient's nervous and circulatory systems before coming under the care of the surgeon.

By neglecting all of the precautions advised against the production of hyperthyroidism during the operation it is possble to cause this condition occasionally even in operations for the relief of simple goitre; but with reasonable care this can always be avoided.

Supply of liquid. Immediately after the operation it is well to supply an abundance of liquid to the patient in the form of hot water taken by mouth, or normal salt solution given as an enema by the continuous drop method, or if neither of these methods can be applied, by subcutaneously injecting normal salt solution into the tissues underneath the breasts. This is especially useful for the relief of post-operative hyperthyroidism.

Detail of minimal dangers. By performing this operation in such a systematic manner the dangers to the patient are reduced to a minimum. Indeed, all of the recognized dangers are practically eliminated. Ether anesthesia which is permanently stopped before beginning to operate, removes all danger from this source. It also disposes of the danger from post-operative ether pneumonia inasmuch as the patient exhales practically all of the ether during the operation. The arrangement of the gauze bandage on the mouth and nose prevents infection from this source. Injury to parathyroids and recurrent laryngeal nerves is carefully avoided. The gentle manipulations of the gland and accurate hemostasis prevent difficulty from thyroid toxins, and the remaining portion of the gland prevents cachexia strumipriva.

There are, however, cases which are too weak to bear even this simple operation and which seem to be unable to make further progress without operative aid. In these it is well to follow the suggestions of Kocher to ligate first one vessel under cocaine and, after a few days, another, until it seems safe to remove the diseased gland.

Tuholsky in an admirable paper suggests the plan of preventing the toxic effect of thyroid secretion by ligating both superior and inferior thyroid veins. This is worthy of the attention of experimental research laboratory workers in this field.

Lowered mortality. For statistics the contributions of Mayo, Kocher and Crile should be consulted. They show one very important practical point which we wish to emphasize, in connection with many others, namely, that the operative mortality has decreased enormously both with the accumulation of the total surgical experience in this field and with the enlarged surgical experience of each individual operator. In the history of all surgical progress whenever this has occurred the time was near for uniform methods to become established.

The first case of exophthalmic goitre we personally operated has now been perfectly well since 1891. The patient was a young woman twenty-two years of age, with typical symptoms, becoming constantly worse under internal treatment. There was marked exophthalmos, severe nervous symptoms, only a moderately enlarged nodular lateral lobe and marked tachycardia. Her pulse had remained above 140 beats per minute during several weeks of observation previous to operation.

The rapid and permanent disappearance of all of these symptoms after operation encouraged us to employ surgical treatment in all cases which did not recover permanently by internal treatment, and such a course has been pursued ever since that time.

Recent advancements. During the past few years this subject has been taken from the field of experimental surgery and placed among those which are looked upon as fairly well settled by all surgeons who have had an opportunity to build up a fair clinical experience in this especial branch. This change has been accomplished, especially during the past few years, through the investigations of the internist in the direction of diagnosis, through the physiologist in the study of living pathology (largely through experimental work) and by the surgeon in simplifying the technique of surgical treatment. So thoroughly have all these points been studied that it may now be reasonably expected that the primary diagnosis having been made, certain cases may be relieved permanently by internal treatment, while others will be improved only temporarily by internal treatment, and that this latter class should be subjected to surgical treatment at an early stage of the disease, before the effects of the toxins have hopelessly impaired especially the muscles of the heart and the nervous system. Under such circumstances it may be expected that there will remain only a small proportion of cases that will not be benefited either by medical or surgical treatment, that still a smaller proportion of the extremely violent cases will succumb to the disease without an operation, and only a very small percentage die after operation.

Experience has shown that with early diagnosis and proper selection of cases the mortality after surgical operation is extremely small and that this percentage is decreased from year to year so that it will be reasonable to expect an operative mortality of less than one per cent. within a few years in the hands of competent surgeons.

In the same manner unfavorable late results are sure to decrease, as already the most dreaded ones have been practically eliminated. We no longer encounter post-operative cases of cachexia strumipriva, tetany, paralysis of the vocal cords, and but very rarely recurrence of the symptoms of the disease itself.

Conclusions. 1. The diagnosis of cases of exophthalmic goitre regarded as suitable for surgical treatment is relatively easy and should be made early. 2. All cases of exophthalmic goitre which are not relieved permanently by rest, hygienic, dietetic and medicinal treatment should be treated surgically before there has been irreparable harm done to important structures. 3. This is especially to be borne in mind in connection with a class of cases that respond readily to non-surgical treatment only to relapse at once upon the slightest strain. 4. The dangers of the operation depend largely upon the harm done by the disease before the operation. 5. These dangers may be eliminated by early operation and by preliminary treatment with rest, hygiene and diet. 6. The operative danger lies in the anesthetic, sepsis, acute hyperthyroidism, tetany, cachexia strumipriva, injury to the recurrent laryngeal nerve, hemorrhage and shock. 7. All of these dangers may be eliminated easily with reasonable skill and attention to details. 8. The patient should receive carefully directed after-treatment, with rest, hygiene and diet, following the operation until especially the blood, the nervous system and the heart have thoroughly recovered from the effects of the disease. 9. All psychic excitation should be prevented before, and for a long time after, the operation.

After-treatment. We are often consulted by some unfortunate patient who considered herself so completely cured by the removal of an enlarged thyroid gland that she proceeded to indulge in the same physical, mental, emotional and dietetic excesses which may have had much to do with the primary disease. In many cases alcohol, tobacco, tea and coffee have been used to excess.

It is extremely important, therefore, to give these patients definite direc-

tions to avoid overwork, excitement, alcohol, tobacco, tea and coffee, late hours, social and business worries absolutely and permanently, after recovering from the operation, and to select a diet largely composed of milk, cooked vegetables and fruits. We make it a rule to give all patients the following printed list of directions to follow after they return to their homes, and emphasize thoroughly the fact that the permanency of their cure depends largely upon the care with which they carry out these directions.

Directions to the patient following operation for goitre. It is of the very greatest importance that the following directions be carried out as nearly as possible, not only to thoroughly re-establish health and strength, but also to maintain this after it has been established, because the causes which brought on the disease in the first place frequently produce a recurrence if the same errors in diet, hygiene and physical, mental or emotional exhaustion are again committed.

1. Avoid all excitement or irritation, like attending receptions, shopping, church-work and politics. If anything happens to annoy you, put it off for a week.
2. You should get an abundance of rest, by going to bed early and taking a nap after luncheon.
3. You should have an abundance of fresh air at night, consequently you should sleep with wide open windows, or on a sleeping porch.
4. You should take nothing that irritates the nervous system, like tea, coffee, or alcohol. Of course you should not use tobacco in any way.
5. You should eat very little meat. If you are very fond of meat take a little beef, mutton or breast of chicken or fresh fish once or twice a week or at most three times a week.
6. You should drink a great deal of milk or eat things that are prepared with milk, such as milk-soup, milk toast, etc., also cream and buttermilk are especially good for you.
7. You should avoid beef-soup or beef-tea or any kind of meat broths.
8. You should eat an abundance of cooked fruits and cooked vegetables, or very ripe, raw fruits, or drink fruit juices prepared out of ripe fruits.
9. You may eat eggs, bread, butter, toast, rice, cereals.
10. You should drink an abundance of good water, or if this is not available you should boil your drinking water for twenty minutes or drink distilled water.

MALIGNANT GROWTHS OF THE THYROID GLAND

Results of operations unsatisfactory. Operations for the relief of malignant growths of the thyroid have been so unsatisfactory in their results that it seems doubtful whether they should be undertaken. It is to be hoped that our experience in the use of the X-rays will continue to be favorable in these cases, but at the present time nothing positive can be said in this regard. If a removal is made the same steps are to be carried out that have just been described.

In several cases we have found small malignant growths in what was supposed to be a simple goitre, and these cases have been free from recurrence, but in those in which the diagnosis was possible before the operation we have never been so fortunate and, according to Crile, this has been the general experience of surgeons.

If the enlargement in the thyroid is circumscribed, taking the form of a fibroid tumor or a cyst, usually colloid, or a circumscribed adenoma, it is unnecessary to remove an entire lobe of the gland. In this event an incision is made over the enlargement in such a manner as to produce as little deformity as possible. Then the capsule of the gland is split, care being taken to grasp portions of the capsule between two pairs of forceps before cutting

it in order to prevent hemorrhage. When the nodule in question is exposed a point of cleavage between it and the remaining portion of the gland is sought and the mass is readily enucleated either with the finger, a Kocher's director or a blunt dissector. In case of troublesome hemorrhage tension is made upwards upon the forceps which have been applied to the capsule and a few stitches passed through the walls of the cavity from which the growth has been removed, and tied with just sufficient tension to overcome the bleeding. The capsule is then sutured and the skin is sutured over it. If the cyst is of large size the whole lobe of the gland should be thoroughly exposed.

If the precautions which have been mentioned are borne in mind the operation is relatively very safe, unless it is done during a condition of severe dyspnea, which may occur at any time in cases in which there is much pressure upon the trachea from an acute edema of the growth. In such an event it is frequently unsafe to anesthetize the patient and then it is best to cocainize the line of skin incision with a one per cent. solution of cocaine and to infiltrate the deeper layers with a one-tenth of one per cent. solution of cocaine in a normal salt solution. The pressure is almost always due to an enlargement of the middle lobe, and it is consequently wise to make a horseshoe-shaped incision, through the skin with the convexity downward, to grasp the vessels rapidly between two pairs of forceps, to cut them, and as soon as the middle lobe is exposed, to insert into it sharp-pointed retractors with at least four teeth, the ordinary catspaw variety being the most useful, and with these to lift the lobe upwards and thus dislodge it from its location behind the sternum where it causes the pressure which gives rise to the condition of dyspnea. After this lobe has once been dislodged the dyspnea ceases and the remaining steps of the operation may be completed without difficulty and without danger to the patient. We have found it necessary to operate upon patients in this condition in the sitting posture, as in the recumbent position they were entirely unable to breathe.

TUBERCULOUS GLANDS OF THE NECK

Pathogenesis. In the treatment of tuberculous glands of the neck the first consideration must be the removal of tuberculous material from the body in order to prevent further infection. The glands which are first infected have progressed furthest in the changes which are due to the presence of tubercle bacilli. In the earlier stages the gland is hypertrophied and contains numerous tuberculous foci which may be separated by normal gland tissue, or a number of these foci may have developed so closely together that they will form one nodule. Presently more and more of these foci will develop in close proximity and then the nutrition of this portion of the gland will become impaired and caseous degeneration will take place. It is important to bear this in mind because in this way one can recognize the direction from which the infection has taken place, which in turn will affect the plan of treatment. The source of infection is most commonly found in tuberculous foci which have developed in the tonsils. This infection may occur from particles of food containing tubercle bacilli becoming lodged upon the surfaces and within crypts of the tonsils; from particles of sputa containing bacilli lodged in the same manner; or from mucus descending from the posterior nares containing bacilli which have been lodged in this mucus from dust in the air.

Patients suffering from tuberculous glands of the neck have usually lived in surroundings in which the dust was likely to contain tubercle bacilli owing to the careless disposition of sputum of patients suffering from tuberculosis of the lungs, or they have been in the habit of drinking unsterilized milk.

Causative influences. In our own practice children living under unhy-

gienic surroundings in houses containing tuberculous patients, and children coming from the farms where they live to a very large extent upon uncooked milk, are the two classes in which we have found this condition most commonly. In the vast majority of these patients we have been able to determine the presence of tuberculous foci in the tonsils in children, or in the apices of the lungs in adults. These facts are of very great importance because if they are not recognized our treatment is not likely to benefit the patient greatly, as a reinfection is almost certain to occur as soon as the patient is exposed to the influences which first gave rise to the disease.

Clinical instance. A young lady eighteen years of age, living at home and taking care of her three younger sisters, gives the following history, which is typical of these cases in many respects, and may well serve to illustrate the etiology and diagnosis of this disease.

Her mother died at the age of forty-two from tuberculosis of the lungs, when our patient was but twelve years of age. The father is in excellent health; her three younger sisters are also in perfect health. The patient suffered from whooping-cough, measles and scarlet fever while still young, having the last named disease at the age of six. After this time she suffered frequently from a mild form of tonsilitis, the tonsils remaining greatly enlarged and swelling to such an extent as to almost close the pharynx, making it difficult to breathe through the nose whenever they were at all congested. Shortly after her mother died she first noticed a small swelling beneath her left ear. This varied in size, but was always larger when she suffered from colds. Several months ago her general condition became impaired and she became quite anemic. At about the same time she noticed several swellings beneath the first one and a further swelling beneath the angle of the jaw on the left side. These have increased in size slowly but constantly, the latest one being located directly above the clavicle.

The patient is fairly well nourished; her appetite fair; her tongue is clean; the bowels are fairly regular; the temperature is normal; pulse 100, full and strong; her heart, lungs and kidneys are normal. She is quite markedly anemic. There is a series of swellings extending from a point beneath the mastoid process along the anterior border of the sterno-cleido-mastoid muscle down to the clavicle; several nodules beneath the angle of the jaw on the left side; also a deep swelling apparently underneath the sterno-cleido-mastoid muscle. None of these swellings fluctuate. The examination of the blood shows the amount of hemoglobin decreased, but otherwise it is normal.

This history is a typical one in cases of tuberculosis of the cervical glands. Scarlet fever and measles are so common in this community that it would be difficult to prove a connection between these conditions and tubercular glands of the neck, but in a majority of these cases one will find that a certain amount of infection remains in the tonsils, which in turn undoubtedly makes the tuberculous infection of the lymphatic glands of the neck more likely.

In this case the oldest child was associated with her mother during the latter's sickness from pulmonary tuberculosis, the younger children being cared for by relatives. This would account for the infection of the oldest, and for the freedom from infection in the three younger daughters. The slowness in the progress of the disease may be accounted for by the fact that the child was naturally strong and healthy and that she has always lived under good hygienic surroundings, with the exception of the time she was with her sick mother. The same conditions account for the good health of her younger sisters.

The history contains one feature which is quite common in these cases, viz., that relating to the variation in the size of the glands during the early part of the infection; the increase in size corresponding to the time when the patient was suffering from cold—in other words, during the acute reinfection. Had this patient been subjected to proper treatment at this time it is quite possible that the existing swelling in the glands would have disappeared entirely, but one cannot make a positive statement regarding this, as the existing initial infection is much more severe in some cases than in others.

For four months this patient has been treated very properly by means of internal medication. She has been given tonics, her work in school has been interrupted, and she has been out-of-doors a great share of the time. Her

household cares have been reduced. She has also received some form of creosote, which is supposed to have a direct effect upon the tuberculous infection. Her general health has been greatly improved in the meantime, but there has been a slight increase in the size of the swellings, although this has been very slow.

There are two reasons why in this case this form of treatment has not resulted in a reduction in the size of these swellings, or possibly a cure. In the first place the primary source of infection is in the tubercular foci contained in her greatly enlarged tonsils. Secondly, the degree of infection in the lymphatic glands of her neck has already advanced to such an extent that its absorption is not to be expected. It will consequently become necessary for us to relieve her by means of operative treatment.

General treatment. All of these steps may be considered as important features in removing the cause. The second element consists in building up the patient's resistance, which is accomplished mainly by providing hygienic surroundings, an abundance of fresh air, absence from dampness; by living a considerable distance above the ground; by exposure of the air in the living and sleeping room to sunlight; by selecting a proper dwelling; and by dispensing with curtains that obstruct the sunlight; and above all by selecting proper food.

It is important not to tell these patients in a general way that they must select an abundance of wholesome food, but they must be instructed in writing just what to eat, how much to eat and when to eat. All of this must also be insisted upon after an operation has been performed. We would prefer to entrust any early case of tubercular cervical lymph nodes to a surgeon of very slight technical skill, if he thoroughly carried out the above plan, than to a surgeon of the highest possible skill who simply removed the diseased glands and paid no attention to the features just discussed, because in the former instance a very large proportion of these cases would recover permanently without being compelled to undergo any operation, while of those operated there would probably be no mortality; whereas in the second instance there would probably be very beautiful immediate operative results, to be followed by a large proportion of recurrences and a very large proportion of ultimate deaths due to pulmonary tuberculosis.

The surgeon who simply removes the existing tubercular glands in patients coming under his care, even though this be done with the greatest possible skill, is a menace to the community.

The exposure of the neck in these patients to the X-ray, after removing tonsils and adenoids and carrying out the other steps indicated above, has been found very effective by many surgeons while others frown upon this plan of treatment. It has seemed very beneficial to us.

Before proceeding to the description of the operative treatment of tuberculous cervical lymph nodes we should emphasize the fact that in a vast majority of these cases no operation will ever become necessary if the patient receives reasonably intelligent treatment after the first symptoms appear.

This treatment must contain three very distinct elements. In the first place the cause must be removed. If the patient is surrounded by persons suffering from pulmonary tuberculosis who are the producers of the tubercle bacilli which infect the patient, then such should be placed in a sanitarium where they will be taught how to protect their associates by the thoroughly established methods which have been successfully tried in such institutions. They should be taught the dangers of coughing into the air, of expectorating except into a receptacle which can be boiled, or into a paper napkin which can be burned. Moreover, they should be taught how to sterilize milk and meats. If the dwelling is unhygienic this should be changed. The local foci in the tonsils, and the adenoids, should be carefully removed. The patient

should be given breathing exercises consisting of inhaling to the fullest extent and exhaling by blowing through a small opening between the lips.

Technique of operation. In this operation we must consider:—

1st. The deep jugular vein, as its injury might result in the introduction of air into the circulation, causing air-embolism and death.

2d. The carotid arteries and the pneumogastric nerve.

3d. Some of the more important branches of the spinal accessory nerve must be preserved, because their injury results in marked deformity, due to paralysis of the trapezius muscle, and consequent discomfort to the patient.

4th. The scar should be so placed as to cause in itself as little deformity as possible.

An incision, therefore, is made along the anterior edge of the sterno-cleido-mastoid muscle, from the mastoid process down to the clavicle. The superficial fascia is carefully dissected back on each side of this incision. The first incision severs the external jugular vein, which should at once be caught and ligated on each side of the division, or it is still better to grasp the vein between two pairs of forceps and to cut it after it has been thus caught, and then ligate at once. The edges of the wound should now be carefully retracted and a dissection begun at the lower end of the incision. This should be carried on carefully until the sheath of the deep jugular vein is reached, which may be followed upwards until the entire vein has been laid bare from the clavicle to the angle of the jaw. The lymphatic glands are closely adherent to the sheath of the vein, but with the vein plainly in view there is no danger of injuring it if the dissection is pursued carefully.

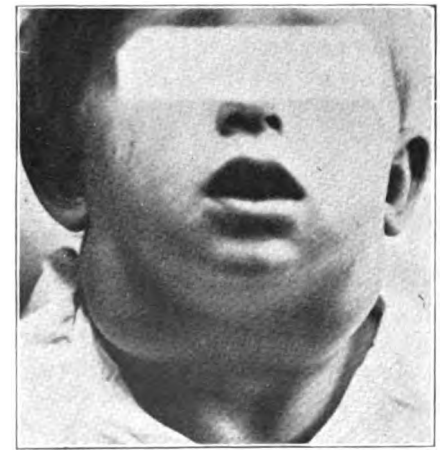
About an inch below the angle of the jaw we find several enlarged glands. This is at the point at which the facial vein enters the deep jugular. It is a favorite location for a tuberculous lymphatic gland. Great care must be taken in dissecting out this gland as one is in danger of injuring the facial or the deep jugular vein, or both. In this instance it is possible to secure a sufficient amount of space without making a transverse incision, but occasionally it is necessary to carry the wound some distance below the lower jaw, and parallel with it, in order to remove all the submaxillary glands. It is not unusual to find the submaxillary lymphatic gland infected with tuberculosis, necessitating its removal. If this is necessary it is best to grasp the facial artery and vein between two pairs of hemostatic forceps and cut between these just below the point where they enter the submaxillary salivary gland, because in this way one can prevent some hemorrhage and the clouding of the field of operation. To the outer side and behind the deep jugular vein the lymphatic glands are also enlarged and we carry our dissection upwards behind the edge of the sterno-cleido-mastoid muscle. About half the distance between the lower and the upper attachment of the sterno-cleido-mastoid muscle, or at a point at which the trapezius muscle approaches the former, several branches of the spinal accessory nerve will be encountered. It is important to preserve these as their destruction will result in a drooping of the shoulder and an atrophy of the muscles of the lower part of the neck. In making the dissection from below upwards the superficial cervical nerve will be encountered passing transversely across the sterno-cleido-mastoid muscle about its middle. A little above this point the spinal accessory nerve passes out of the sterno-cleido-mastoid muscle and thence backward and downward into the trapezius muscle. The superficial cervical nerve being larger and more superficial serves as a guide to the more important spinal accessory. The latter should be carefully dissected out to its insertion in order to avoid an accidental injury.

We have now disposed of all of the enlarged glands with the exception of those underneath the upper portion of the sterno-cleido-mastoid muscle. These may be approached by making a transverse incision through the sterno-

cleido-mastoid muscle, by splitting the latter longitudinally, or, better still, by dissecting the muscle entirely free and drawing it out of the field of operation by means of retractors. The last of the three methods mentioned will be followed here as it does the slightest amount of injury to this important muscle, while the other methods are undoubtedly both harmful and unnecessary.

All the infected glands have now been carefully removed. It is our practice to apply strong compound tincture of iodine to all the raw surfaces with the expectation of destroying thereby any bacilli still remaining in these tissues, and also with the idea of stimulating the tissues to increased healing. Other surgeons use different antiseptics for the same purpose, and still others use none at all, and apparently all are equally successful.

It is wise to supply some means of escape for the serum, which, during the first twenty-four hours, will accumulate from the large raw surfaces. In order that the flaps may not be separated by the accumulating serum, after once uniting, we will insert a small drain in the lower angle of the wound, and then will unite the edges of the wound, using the utmost care to secure



BOVINE TUBERCULOSIS OF THE GLANDS OF BOTH SIDES OF THE NECK IN A CHILD THREE YEARS OF AGE. TREATED BY SURGICAL EXCISION IN TWO STAGES.

a most perfect coaptation, because in this way we will be able to avoid as much as possible the formation of a disfiguring scar.

We are in the habit of uniting the fascia with a separate row of catgut sutures in order to avoid a depression of the scar.

Removal of tonsils and adenoids. The most important part of the operation still remains, for were we to leave this patient in her present condition she would be virtually worse off than when we started the operation, as in removing the diseased lymphatic glands we have undoubtedly removed many normal ones which might serve to protect the patient against further invasions through the same source of infection—which still remains—in other words, we have not only relieved our patient of her diseased lymphatic glands, but also of many lymphatic glands which if left in place would serve to protect her. We must, therefore, remove the cause of infection in this case, which exists in the tuberculous foci in her tonsils, and in the adenoids in the post-nasal space. We therefore place the patient in the inverted position and permit her head to hang backward over the end of the table. We then insert a gag between her teeth to keep the mouth open, and then remove both tonsils; and by means of a broad post-nasal curette we curette away the adenoids, protecting the uvula

and soft palate by inserting the left index finger. In order to complete the removal of these adenoids we further insert a small, ordinary, moderately blunt curette through the nostril, and, guiding the spoon with the left index finger in the pharynx, curette away all of the remaining granulations. This step is taken first through one nostril and then through the other until the pharynx is perfectly free from adenoids. At the same time we examine the patient's mouth and if she has any decayed teeth to act as a source of infection they will be removed.

After-treatment important. In these cases it is especially important that the after-treatment be carefully supervised by the surgeon. One of the most important features of this after-treatment consists in instructing the patient to take breathing exercises systematically. It is our practice to have these patients inhale through the nose with closed lips, filling the chest completely, and then exhale while they resist with the lips. The most convenient way of accomplishing the latter step is by placing between the lips a small tube about two millimeters in diameter. This exercise should be practised at least twenty times in the morning and again as many times in the evening.

The hygienic surroundings of the patient should be favorable. The living and sleeping room should be high, dry and sunny. The food should be nourishing and simple and the patient should have an abundance of outdoor exercise. Tonics and anti-tubercular remedies should be given systematically until full recovery, and a patient's habits should be so formed that it becomes natural for him to live hygienically.

It is far more important that these last mentioned directions be carried out than that the tuberculous glands be removed, because if these hygienic measures are carefully followed the patient will usually live much longer and be in much better health, even though the glands be not removed, than would obtain if the glands were removed after the most perfect method and no attention paid to the dangers by reinfection. The plan which must consequently result in restoring these patients permanently to good health, and to the lengthening of their lives to the greatest possible degree, consist in removing all of the infected glands, as well as the primary foci of infection whenever this is possible; in improving the hygienic conditions and the food; and in administering tonics and anti-tubercular remedies; all of which can only be accomplished by impressing the patient with the importance of the conditions and the consequences.

The principles laid down above regarding the operation for removal and the after-treatment of tuberculous glands in the neck will apply to tubercular glands in general without regard to the location in the body. It is characteristic for these glands to be adherent to the veins wherever they may occur, because the lymphatic glands which are most likely to be infected by tuberculosis are all located in close proximity to the larger veins of the body.

General prognosis. If the tuberculous glands of the neck which do not disappear under internal and hygienic treatment, and after the removal of the focus from which the original infection has taken place, are removed, and the internal and hygienic after-treatment which has been outlined here has been followed, then the prognosis in these cases is good both as regards immediate and permanent results. If broken down tuberculous glands of the neck are not removed the degeneration may proceed to calcification of the caseous portion of the gland and the patient may still recover, or adhesions may take place between the gland and surrounding structures, and the accumulation of tuberculous material may result in a sufficient amount of pressure-necrosis of the overlying tissues to cause a perforation through the skin and spontaneous drainage. This may continue for a considerable time, or may be relieved by means of an operation. In the former case the patient remains ill for a long

period, and if a spontaneous cure results it will be accompanied by a considerable amount of deformity.

Again, the infection may progress from one set of glands to another until all of the cervical lymphatics have become involved. Then the space occupied by the lymphatics extending from the neck into the axilla behind the clavicle may be affected and there may be a tuberculous infection of the axillary lymphatic glands; or, again, the infection may extend along the median line into the cavity of the chest. Each of these conditions is, of course, much more serious than the original infection; consequently the danger should be interrupted before it has progressed to one or the other of these unfortunate results.

During the past few years so much progress has been made in the hygienic and dietetic treatment of pulmonary tuberculosis that all that has been said above should be supplemented by directing the patient to live precisely as he would be directed to were he suffering from incipient pulmonary consumption. He should live, and especially sleep, out-of-doors, eat an abundance of eggs, beef and mutton and drink at least two quarts of milk daily, from tuberculin-tested cows, or, if ordinary milk is used, sterilize it without boiling. A sterilizing apparatus may be improvised in the poorest kitchen by the use of a fruit jar and an ordinary kettle in which a cloth has been placed to prevent the heat from cracking the fruit jar. The latter, containing the milk, should of course be placed in the water in the kettle before very much heat is applied.

The water should boil about the fruit jar at least twenty minutes.

The patient should also eat an abundance of cooked vegetables, cereals and cooked fruits, with bread and butter, but none of the non-nutritious condiments. Alcohol in every form is harmful and should be tabooed.

Use of Beck's bismuth paste. In old cases that have suppurated and in which there are resulting sinuses the injection of a sufficient amount of Beck's bismuth paste every two to six days, so as to fill the sinus without over-distending it, and closing the external opening with a gauze plug, will speedily disinfect the discharge and the sinuses will usually heal in a short time.

The tonsils and adenoids must of course be removed in these as in the other cases, to prevent reinfection.

Later it is advisable to excise the disfiguring scars marking the position of the sinuses, and to close the defect carefully so as to reduce the deformity to a minimum. It is best not to perform this secondary operation until after the sinus has been healed for at least one year, for fear of having the edges of the wound break down after suturing, leaving an unsightly scar.

HODGKIN'S DISEASE

The lymphatic glands of the neck frequently undergo a form of enlargement and degeneration which is probably also infectious in its character, but in which we are not able at the present time to determine the nature of the infection. Bunting and Yates have isolated from these glands a diphtheroid bacillus, pleomorphic in type, which they hold is the causative factor in Hodgkin's disease. This has not been generally accepted as yet, and the finding of this, or an organism so similar to it that they are scarcely distinguishable, in lymph glands from patients suffering from a variety of diseases and in glands from normal persons, has given rise to the belief that the cause of Hodgkin's disease is not yet known. Nor has vaccine or serum therapy, using the Bunting-Yates organism in the production of these vaccines and serums, proven satisfactory.

The condition is rarely entirely confined to the region of the neck, the lymphatic glands in other portions of the body being enlarged also. The glands are harder and usually more closely grouped than in tuberculosis. The patient

is anemic or cachectic in appearance. Upon removal of a gland it is found to contain a uniform structure in which there are no circumscribed tubercles or foci of caseation. These glands contain an abundance of connective tissue and the spherical cells of the normal lymph gland will be seen to have lost their characteristic appearance.

The removal of the enlarged lymph glands in Hodgkin's disease does not benefit the patient except when their presence interferes with respiration by pressure upon the trachea. In a considerable number of these cases there has been a rapid disappearance of the glands under treatment with the X-ray, but it will be necessary to follow them further before anything positive can be said on this subject.

Hygiene and diet should be carefully regulated. The patient should also receive tonics and from one-half to two grains of sodium arsenate given hypodermically each day in a five per cent. solution of distilled water. This seems to be beneficial.

LYMPHATIC LEUKEMIA

Enlargement of the cervical lymphatics as a result of lymphatic leukemia may be differentiated from Hodgkin's disease and from tuberculous adenitis by the marked increase in the leucocytes in the blood. The treatment of lymphatic leukemia is not surgical.

LYMPHO-SARCOMA OF THE NECK

This disease is differentiated from the other conditions which are similar in appearance, and that have just been described:—

1st. By the absence of a history of tubercular infection.

2d. By the fact that the surrounding tissues are invaded very soon after the beginning of the disease.

3d. By the rapidity of its development; and

4th. By the early appearance of cachexia.

The excision of a sarcoma of the neck is the only treatment which has heretofore seemed to promise anything for the patient. From the anatomical conditions present in this region an extensive removal is, of course, not possible, and consequently these cases, with very few exceptions, have been hopeless; and still there are undoubtedly a few that have recovered permanently. The after-treatment with the X-ray seems to be of great importance. We have seen severe cases in which recurrent nodules have disappeared permanently after use of the X-ray.

CARCINOMA OF THE LYMPHATIC GLANDS OF THE NECK

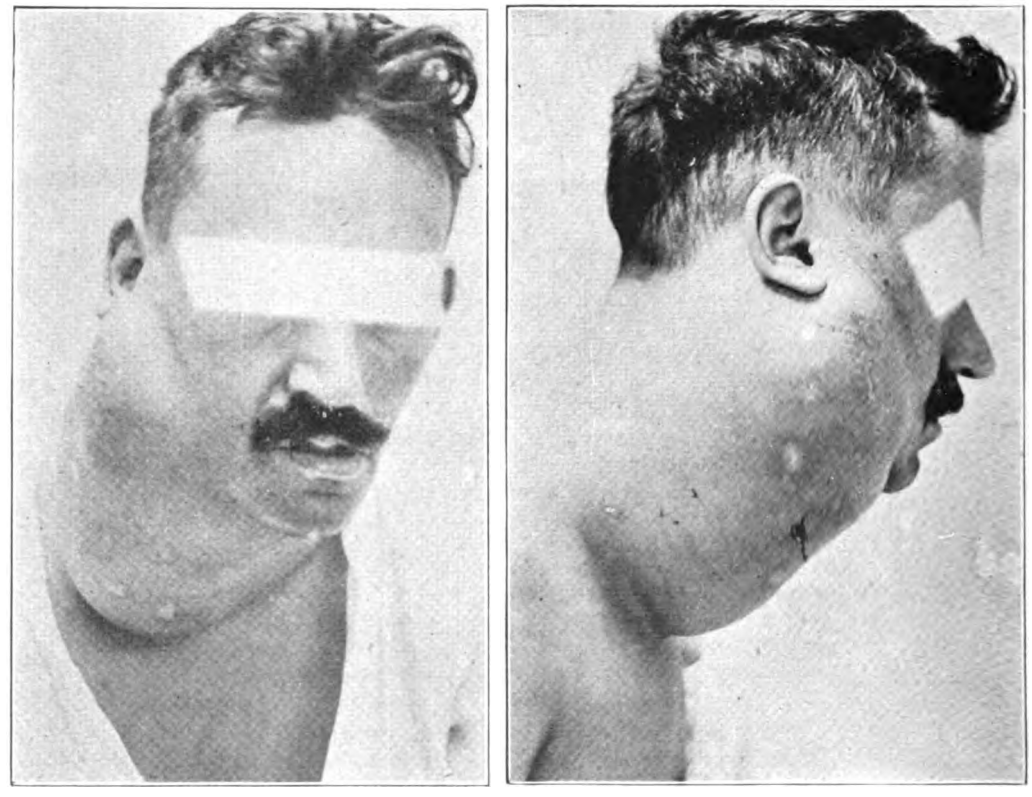
This is always secondary to the presence of carcinoma of some portion of the face, pharynx, parotid gland, or tonsil, which will differentiate it from the conditions which have just been described. Thorough surgical removal is the only treatment that promises anything, with the possible exception of treatment by the X-ray. The condition is, therefore, almost hopeless.

In operating every structure, with the exception of the pneumogastric nerve, that may be even slightly involved must be excised. We prefer to make the excision with the cautery in order to prevent reinfection with the carcinoma tissue and toxin.

These cases should all receive vigorous after-treatment with the X-ray.

DIFFUSE DISSECTING LIPOMA OF THE NECK

This usually begins in the median line opposite the spinous processes of the cervical vertebræ, and becomes wider in every direction until it covers the entire posterior surface of the neck, giving the appearance from the rear of an enormous collar of fat. Laterally it advances around the neck until its two wings meet, unless an excision is made before this occurs. The tumor is lobulated, is from 1 to 5 cm. thick, and it has the peculiar quality of following the connective tissue in every direction by dissecting its way between the other structures and apparently consuming the connective tissue



LARGE SARCOMA OF THE NECK—INOPERABLE.

on its way, hence the name of dissecting lipoma. Its lobules will insinuate themselves between the muscle fibres of the neck, between the lobules of the parotid and thyroid glands and, in fact, between all of the structures which contain connective tissue.

It causes much distress from its weight and from pressure, and is extremely unsightly. The patients acquire an appearance which reminds one of the cachexia in malignant disease, although milder in form.

As soon as the diagnosis has been made the growth should be excised by means of a most painstaking, exact dissection, because if any lobules remain a recurrence is to be expected. In severe cases it is best to remove one-half of the tumor first in order to enable the patient to lie down with some degree of comfort. After the one side has healed fully the other may be operated.

These surfaces are so large that drainage is indicated, otherwise serum

is likely to accumulate under the large flap and healing will therefore be retarded. The drainage may be removed on the second or third day after the operation.

SEPTIC INFECTION OF DEEP TISSUES IN THE NECK

Quite frequently in infants, and occasionally in adults, there is a septic infection of the deep tissues of the neck resulting from an infection of the tonsil or some portion of the pharynx. The condition is violent in its onset and there is a severely indurated, extensive swelling which usually begins in the upper portion of the neck and extends downward. The induration is often so severe that fluctuation cannot be determined. Pus, however, is always to be found in the deeper tissues and its removal by means of an incision, and the subsequent application of drainage and a moist antiseptic dressing, results in a rapid recovery. The incision should be made carefully, because there is sometimes a displacement of the anatomical structures, and unless care is taken these are likely to be injured during the operation.

After the incision has been made through the skin and superficial fascia it is often best to separate the deep tissues bluntly until the small abscess is reached, rather than to run the risk of injuring important parts, especially the deep jugular vein.

LIGNOUS INFILTRATION OF THE NECK

Lately a condition has been classified separately from other extensive infections of the neck because of the extreme board-like hardness of the tissues incident. The affection progresses rather slowly but causes profound distress because of the fact that the tissues are quite unyielding, having much the appearance of infiltrating skin cancer—*cancer en cuirasse.*

The tissues cut like cartilage and although they are evidently filled with serum and with leucocytes the surfaces do not secrete fluid like that found upon incising skin in the presence of ordinary edema.

The tissues should be freely incised and the deep structures freely separated, much the same as heretofore described. Usually a focus of infection will be found containing a few drops of pus. A large, hot, moist dressing consisting of two parts of a saturated solution of boric acid and one part of alcohol, should be applied, and this should be covered with an impermeable substance like rubber tissue, held in place by a roller bandage. The prognosis is favorable.

TORTICOLLIS

Space will permit us to discuss only the treatment of the non-spasmodic form of torticollis, which depends upon a shortening of the sterno-cleido-mastoid muscle.

The form of treatment which we have found most satisfactory consists in carefully dissecting out the sterno-cleido-mastoid muscle, or what is left of it, together with the cicatricial tissue which may compose a portion of the muscle. Having laid bare the entire muscle it is split in halves longitudinally to a point within an inch of its upper, and to the same distance with regard to its lower extremity. Each half is now permitted to remain attached to one end, while at the other end of the incision through the muscle it is cut loose so that the upper attachment carries one-half of the muscle and the lower attachment the other half. The head is now turned so that the chin reaches the shoulder of the side on which the short muscle exists, in order to determine the length

desired, and the two ends are united by means of a number of fine catgut sutures. After the head is turned back so that the chin is opposite the sternum the sutured muscle will appear considerably relaxed. It will give the impression of being quite a little too long. It is now covered with the superficial fascia by means of a row of catgut sutures and the skin is sutured over all. This leaves the diseased side entirely without tension. The muscle usually fills up quite rapidly, and, in our experience, the deformity has not recurred and the function has been very satisfactory.

Recently we have made an incision through the skin along the upper edge of the clavicle, thoroughly exposing the sternal as well as the clavicular attachment of the sterno-cleido-mastoid muscle. All of these attachments were then severed entirely and the muscle was followed upward and all adhesions were cut which seemed in any way to interfere with an absolutely free movement of the neck and head. Then two small drains were inserted into the angles of the wound which was then sutured. The wound in the neck made by this operation is sometimes very deep, as unless all fibres are severed the operation must fail.

The chief advantage in this operation lies in the fact that no scar is produced on the exposed portion of the neck. The disadvantage rests in the fact that any surgeon who has not witnessed the operation at the hands of a trained operator is not likely to do the work with sufficient thoroughness to give a satisfactory result.

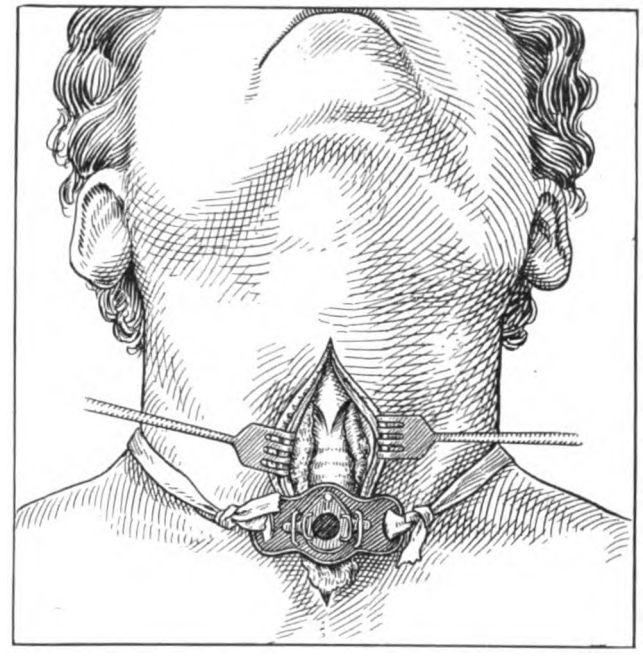
In order that the cut ends of the muscle remain apart, it is necessary in these cases to apply a plaster of Paris cast with the head in an exaggerated, overcorrected position. With the patient in a sitting position and two layers of stockinette applied over the entire head and upper trunk, with holes for the arms, plaster of Paris bandages are applied involving the entire head, chin, neck and chest to the ensiform process. An oval opening is made for the face from the superciliary ridges to a point 1 cm. beneath the margin of the lower lip. This cast remains in position for three to four weeks, the stitches having been removed through a small "window." A lighter cast or special brace should then be applied for from six to eight weeks, always with the chin turned to the side of the deformity.

SPASMODIC TORTICOLLIS

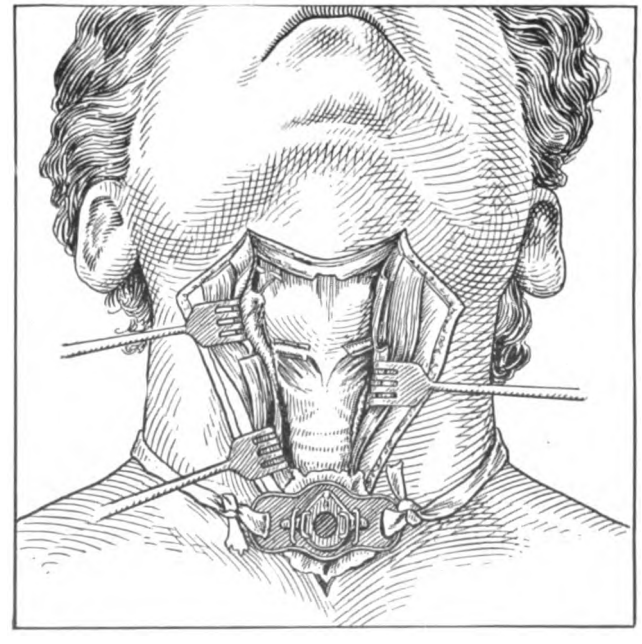
Where this condition is absolutely limited to spasmodic contractions of one sterno-cleido-mastoid muscle it is proper to sever the spinal accessory nerve supplying this muscle, but in every case that has come under our care other muscles were involved and consequently such an operation could not relieve it satisfactorily. In severe cases the condition is, however, so distressing that resection of the nerves supplying the muscles involved would be justified, in case the patient would be willing to exchange his distress for the resulting paralysis.

TRACHEOTOMY

Since the introduction of diphtheria antitoxin tracheotomy is performed almost entirely for the relief of obstruction to respiration due to the introduction of foreign substances into the larynx, such as the inspiration of kernels of corn, or other objects, by children at their play, or the forcing down of the diphtheritic membrane in the attempt to introduce an intubation tube. It is also done for the removal of foreign substances that have been inspired, and for the relief of obstruction to the larynx due to malignant growths.



By the courtesy of Dr. George E. Brewer, representing the preliminary tracheotomy with peritracheal tamponade preparatory to performing laryngectomy.



By the courtesy of Dr. George E. Brewer, representing his exposure of the larynx and thyroid membrane in his operation of laryngectomy.

Technique. The seat of the operation may be chosen either above or below the isthmus of the thyroid gland, or should the patient be in danger of asphyxiation, necessitating a very rapid operation, the incision may be made directly through the isthmus of the thyroid gland, the latter having previously been grasped between two pairs of hemostatic forceps. When the operation has to be performed with extreme rapidity it is best to place the patient in the inverted position with the head dependent so that any blood which it may not be possible to control at once will gravitate away from the opening in the trachea and will not be inspired. If sharp tenaculæ are at hand it is wise to plunge two of these directly through the skin into the trachea on each side of the median line and then to make an incision directly into the trachea with one sweep of the knife and to hold the incision open by drawing upon the tenaculæ while artificial respiration is performed. In the meantime the bleeding vessels may be caught, and if a tracheotomy tube is at hand it may be inserted. This, however, is not at all an attractive operation and should never be done except in the presence of absolute necessity. If the operation can be done leisurely the important points to be considered are:

1st. To control the hemorrhage in the successive steps before the blood vessels are cut. An incision should be made in the median line and each blood vessel caught with two pairs of hemostatic forceps as it appears in the wound, and then the incision should be continued. In this manner the operation should proceed until the rings of the trachea are plainly in view; then all the vessels should be carefully ligated and any further bleeding points caught with forceps and tied, and then the two tenaculæ should be passed through one of the tracheal rings to either side of the median line and the trachea incised longitudinally, one, two or three cartilaginous rings being cut transversely.

2nd. Should it occur that the operation is performed for the removal of a foreign body from the trachea or larynx it is wise to have an experienced assistant prepared to catch the foreign body the moment the trachea is opened, inasmuch as such a body is frequently forced out, together with a lot of tenacious mucus, the moment the trachea is incised. After this there is usually a deep inspiration which may again draw the substance into the trachea and possibly cause it to become lodged in one of the larger bronchi. And it may be difficult to dislodge it from such a point.

In the after-treatment it is wise to guard against the irritation of the lungs on account of the effect which the air has in coming directly in contact with the mucous membrane of the trachea and bronchi without first passing through the nose and pharynx. This irritation may be avoided by placing over the opening a wire frame on which a layer of gauze has been stretched, which is kept moist with normal salt solution.

The tracheotomy tube should consist of an outer and inner tube, the latter being changed frequently enough to prevent the accumulation of mucus. It is a good rule to leave a tracheotomy tube in place as short a time as possible, because some portion of the outer tube is liable to do injury to the trachea, and the longer it is left in place the greater is the likelihood of permanent injury being done to this structure.

INTUBATION

Since the introduction of antitoxin, intubation has been found quite sufficient to relieve the obstruction of the larynx due to diphtheria. It is rarely necessary now to leave a tube in place for more than one or two or, at most, three days, because the diphtheritic membranes have usually disappeared entirely within this time if large doses of antitoxin have been given.

Accompanying difficulties and their correction. The difficulties which accompany intubation are:

1st. The danger of forcing portions of the diphtheritic membrane down into the trachea.

2nd. The danger of injuring the vocal cords.

3rd. The danger of the patient coughing out the tube in the absence of the physician, and the inability of the nurse to replace it.

4th. The difficulty some people have in taking food in the presence of an intubation tube.

5th. In rare cases the intubation tube will touch a point in the larynx, at the base of the epiglottis, which seems to produce an immediate paralysis of the respiratory centers, causing almost instant death unless artificial respiration be performed until the effect of this traumatism has passed away.

(1.) The first difficulty must be overcome by an immediate tracheotomy; consequently the surgeon should always be prepared to perform a tracheotomy before he begins intubation. This, however, becomes necessary only very rarely, but when it does the conditions are so urgent that unless the surgeon is prepared to perform tracheotomy at once the patient will probably be hopelessly asphyxiated before the necessary preparations can be made.

(2.) The second danger can be avoided by great care in performing the operation.

(3.) Since the introduction of antitoxin we have never seen a case in which the child suffered seriously from coughing out the intubation tube. Whenever this has happened there has usually been at the same time a loosening of a portion of the membrane so that a replacement of the tube was not necessary.

(4.) Patients who find difficulty in taking nourishment can usually be sustained very nicely if they are placed in the inverted position and permitted to take liquids through a tube.

The first and most important condition to be secured in order to make a satisfactory intubation is perfect rest and quietude of the patient.

Technique. If a patient is able to move, even though to a slight extent, it will be difficult to insert the tube without causing injury to some of the parts. To secure the child so that it cannot move it is best to take an ordinary sheet, have the child's arms placed alongside the body, and then wrap the sheet around and around a number of times so that the arms cannot be removed from the sheet. In attempting to move the arms the child will pull both ways at the same time and the result will be that it will not move at all. The child should then be taken upon the lap of an assistant, its head should be held against the left shoulder, the left arm of the assistant should pass across the lower portion of the child's chest, while the right arm should hold its head firmly against his shoulder. In this way the child can be held perfectly still. The gag is then inserted between the teeth and held by a second assistant who stands behind the one holding the child. The surgeon then inserts the first finger of the left hand into the mouth, lifts the epiglottis upwards and holds it in this position while he carries the tube mounted upon the applicator into the mouth and along the inner side of the index finger. This will guide it directly into the larynx. It is pushed down into the larynx gently and then released from the applicator by the mechanism provided for that purpose. At the same time the index finger is placed upon the tip of the tube and the latter is driven down so that the rim at its upper end rests upon the broad surface of the vocal cords. The applicator is in the meantime withdrawn quickly and this will enable the child to breathe through the tube.

It is wise to leave a firm, silk thread attached to the intubation tube and to have this passed out through the angle of the mouth and fastened upon the

cheek by means of rubber adhesive strips. In this manner the removal of the tube may be accomplished by the nurse in case it should become occluded during the absence of the surgeon.

LARYNGOTOMY

The presence of a foreign body in the larynx underneath the vocal cords, which cannot be forced out by the efforts of the patient and which cannot conveniently be reached through a tracheotomy wound, sometimes necessitates the splitting of the larynx. The same operation is occasionally indicated in the presence of benign growths located underneath the vocal cords.

The important point in this operation consists in the thorough anesthetization of the interior of the larynx by means of a spray of a four per cent. solution of cocaine in water. The patient is placed in the Trendelenburg position with the head dependent over the end of the table. An incision is made in the median line extending from a point an inch above the prominence of the thyroid cartilage to a point opposite the isthmus of the thyroid gland. This incision is carried down to the larynx, care being taken to grasp all of the blood vessels at once. Just before opening the larynx the cocaine spray should again be applied, it having been thoroughly applied just before beginning the operation. Then a sharp tenaculum is inserted on each side of the median line and while an assistant makes a gentle traction upon these tenaculæ a longitudinal incision is made through the larynx. As soon as the larynx is opened there is usually a violent attack of coughing unless the part has been thoroughly cocainized. If a foreign body is lodged in the larynx the first effort of coughing usually forces it out, and the same precaution should here be taken that was mentioned in connection with tracheotomy for the removal of foreign bodies in the trachea. An assistant should be ready to sponge away any mucus that is forced out by the first effort of coughing, because this is likely to contain the foreign body.

In case the operation is performed for the removal of a growth the larynx should again be sprayed with cocaine after it has been opened in order that the operation may not be interrupted on account of coughing due to an irritation of the mucous membrane. The diseased portions may then be so perfectly exposed that their removal is not connected with any difficulty. Hemorrhage is controlled in the usual way, and after the operation has been completed the wound is closed by means of deep and superficial sutures. The deep sutures should not enter the larynx.

LARYNGECTOMY

In the presence of a malignant growth confined to some portion of the larynx its removal is indicated if the surgeon be fairly certain that there has been no secondary involvement.

The same preparations mentioned in connection with laryngotomy should be practised in laryngectomy. If there has been sufficient obstruction to the entrance of air for a considerable time before the patient comes under the care of the surgeon to greatly reduce the strength of the patient a preliminary tracheotomy should be done so that the general condition may be improved before the radical operation is undertaken. If the obstruction is not sufficient to seriously interfere with the patient's breathing then it is just as well to do the operation at once without having made a preliminary tracheotomy.

A study of the literature seems to show that for the expert surgeon it is undoubtedly perfectly proper to perform this operation in one stage, because he will be able to take the necessary precautions to prevent the infection of the

loose connective tissue spaces at the lower end of the incision, which lead directly down into the region of the mediastinum. Most deaths occur as a result of infection through this space and consequently it is most important to guard against it. This can be accomplished most readily by producing a connective tissue barrier by laying bare the trachea for a distance of 4 cm. below the cricoid cartilage and tamponing this space with iodoform gauze for a period of one week, by which time the loose connective tissue spaces will have all been obliterated and it will be possible for the surgeon to perform the remaining steps of the operation with greater safety. It will, however, not be a sufficient protection to warrant anything but the most perfect closure of the pharynx. During the interval of this week the patient should receive an extensive X-ray treatment of twenty minutes duration each day, the neck being shielded by an aluminum plate of one mm. thickness.

The operation should again be performed with the patient in the Trendelenburg position, with the head dependent over the end of the table in order to prevent the entrance of blood into the trachea.

The method of anesthesia practised in connection with thyroidectomy should be employed in this operation, but in addition to this the larynx should be sprayed thoroughly with four per cent. cocaine for ten minutes before beginning the anesthesia in order that the patient may not cough when the trachea is opened. It is important for the patient to inspire deeply during the use of the spray in order that some of the cocaine may reach the lining of the trachea.

It is important also that the patient be very thoroughly anesthetized before the operation is begun in order that no further ether need be given during the progress of the operation.

The advantage of this method is really of much importance both to the comfort of the surgeon and the safety of the patient.

Technique. An incision is made from a point an inch and a half above the prominence of the thyroid cartilage to a point just above the sternum. The vessels overlying the larynx and trachea are carefully caught with hemostatic forceps and cut. The isthmus of the thyroid is grasped between two pairs of hemostatic forceps, cut and ligated. After the larynx and trachea have been carefully laid bare a tenaculum may be inserted into the third or fourth ring of the trachea and the latter cut transversely. It is then rapidly drawn up and loosened so that its upper end faces forwards and acts as a curved tube communicating with the anterior surface of the neck. It is dissected loose sufficiently to project half an inch beyond the margin of the skin, which is button-holed a short distance below the lower end of the incision, so that the end of the trachea may be drawn through. This will aid in preventing the discharge from the wound from entering the trachea and causing aspiration pneumonia. It is then sutured in place by means of several fine sutures which extend through the third or fourth ring of the trachea. The upper portion of the skin incision is left open to facilitate the remaining steps of the operation necessary to remove the larynx. In this manner the patient is enabled to breathe without the danger of inspiring blood. It is also possible by placing the anesthetic upon a piece of gauze held over the end of the trachea to continue the anesthesia without annoyance.

The larynx is now carefully dissected out, beginning from below, loosening both sides simultaneously and controlling the hemorrhage step by step by means of hemostatic forceps and ligatures. It is well to keep the larynx and trachea cocainized in order to prevent the annoyance due to coughing. When the upper end of the larynx is reached care should be taken to cut its attachment in the pharynx so that the latter can be closed by means of sutures. If the pharynx is already involved in the malignant growth the removal of

the larynx is practically useless and a simple tracheotomy will be of quite as much benefit to the patient; consequently in cases proper for the removal of the larynx these flaps can be formed without fear of leaving portions of the carcinoma. The pharynx is then carefully closed, preferably with two rows of sutures, a piece of iodoform gauze is carefully tamponed underneath the wall thus formed in order to provide drainage in case of leakage. The remaining portion of the wound is then carefully sutured by means of deep and superficial sutures.

It is usually not necessary to insert a tracheotomy tube in a trachea which has been brought out in the manner just described. The skin should be carefully sutured above and below, and it is well to protect the wound against infection from the mucus expelled from the trachea by the application of some oily substance, such as vaseline. The dressing must necessarily be small in order that the entrance to the trachea be not obstructed in any way. The same precaution should be taken against irritation from the direct introduction of air into the trachea that was mentioned in connection with tracheotomy. A frame covered with gauze should be fastened over the opening and kept moist by the application of a small amount of normal salt solution. As soon as the wound has healed an artificial larynx may be fitted into the trachea. It is claimed that a sufficient amount of air can be retained in the pharynx to give an audible voice sound, making the use of an artificial larynx unnecessary.

We have seen one case in which the patient could make all of his wants known with perfect ease, and could even engage in conversation. The total amount of air available at any time is, however, so slight that the speech is quite spasmodic.

Until one has considerable experience in performing the operation of laryngectomy it is better to do the operation in two stages because in this manner one can prevent infection of the mediastinal space with almost absolute certainty. The first step consists in laying free the field throughout and also the upper three cm. of the trachea and then tamponing the space with gauze all about the larynx and the upper end of the trachea, which will cause the formation of granulation tissue to protect the deep tissues against infection. The interval between the two steps of the operation should be from one week to ten days. In case the operation is performed for the relief of a malignant growth a daily treatment of X-ray should be given through the open wound during the interval between the operations.

The second stage of the operation should simply complete the steps as described above.

ESOPHAGOTOMY

Foreign bodies frequently become lodged in the esophagus at a point behind the upper end of the sternum. Usually it is possible to grasp them with esophagus forceps and remove, especially if they are of material which makes it possible to locate them by the use of a fluoroscope, with the X-ray tube behind the patient and the surgeon in front. We have been able to pass a forceps into the esophagus, to open its jaws at the moment it touched the foreign body, and to grasp the body conveniently for removal. If this can not be done through the mouth it may frequently be done through an esophagotomy opening.

Technique. An incision seven cm. long is made along the anterior border of the lower end of the sterno-cleido-mastoid muscle, the lower end extending to a point one cm. above the clavicle.

The skin, fascia and platysma are severed. The sterno-cleido-mastoid muscle is retracted outward and the sterno-thyroid and hyoid muscles are

retracted inward, the omohyoid is severed, the outer capsule of the thyroid gland is split and the lobe of the gland is retracted upward. The deep fascia is then split, exposing the inferior thyroid artery, which extends inwards and upwards across the interior border of the longus colli muscle. This vessel is clamped between two pair of hemostatic forceps, cut and ligated. At this point the same care must be exercised in protecting the recurrent laryngeal nerve that was described in thyroidectomy. It crosses the inferior thyroid artery in the form of a delicate white thread-like structure. It is well to retract the nerve with a fine tenaculum toward the median line.

It is important to open the esophagus laterally and not anteriorly, because of the danger of wounding the nerve.

A large steel urethral sound, or an olive-pointed esophagus dilator, is now inserted through the mouth and two fine-toothed forceps are caught in the side of the esophagus, or the same result may be accomplished by placing two fine silk sutures, one cm. apart, in the side of the esophagus and making a longitudinal incision through the wall half way between, the two sutures or forceps being used as retractors.

A large Jacob's retention catheter, or a soft rubber tube, is inserted into the esophagus through the wound and held in place by a suture. This tube should extend at least a distance of 20 cm. into the esophagus so that liquid nourishment may be passed down through it.

The wound is tamponed widely open with gauze and moist antiseptic dressings are applied and renewed every two hours, as the discharge through a fistula in the esophagus is likely to be very offensive.

If the foreign body has not been lodged long enough to cause infection, the wound in the esophagus may be sutured at once with catgut, but should nevertheless be kept widely open with tampons.

If the operation is performed for the relief of obstruction of the pharynx or esophagus above this point a permanent esophageal tube may be introduced to facilitate the feeding of the patient, or the edges of the wound in the esophagus may be sutured to the edges of the skin wound, which will enable the patient to use a removable esophagus tube later on. In most cases, however, the patient is not likely to profit much by this operation for the relief of obstruction due to carcinoma. We have never encountered a case in which the operation was necessary for the relief of obstruction due to cicatricial occlusion, although such cases are, of course, possible.

PART IV

SURGERY OF THE CHEST

EMPYEMA

The most common pathological condition of the chest for which surgical treatment is indicated is an accumulation of pus in the cavity thereof, the result of an infection due to the specific micro-organisms present in a preceding pneumonia, or to the infection of the pleura by means of the bacillus of tuberculosis, or any one of the pus-producing micro-organisms. The condition is usually preceded by an inflammation of the pleura accompanied with serous effusion into the pleural cavity, which later becomes infected. This gives rise to the formation of the pus characterizing the condition of empyema.

Signs and symptoms. There is usually a history of pneumonia accompanied by severe pleuritic pains, or a history of apex tuberculosis. During the accumulation of pleuritic fluid there is shortness of breath and a short, irritable, hacking cough. If the disease is due to a tuberculous infection an evening temperature is likely to be noted; if due to an infection by the pneumococcus the temperature is liable to be persistent.

There is a bulging of the side of the chest involved; upon percussion there is dullness which varies with the position of the patient, except in cases in which the two layers of the pleura are adherent above the empyema. This condition is usually not present except in recent cases, hence it is not difficult to differentiate between the late stages of empyema and hydrothorax by physical examination. If the empyema is extensive there is usually a displacement of the heart. A good-sized trocar inserted between the ribs over the middle of the area of dullness may discover pus, but the absence of pus should not be considered as proof of the non-existence of an empyema, because it frequently happens that the pus is so much thickened that it cannot be withdrawn even through a large trocar. The trocar is useful to differentiate between hydrothorax and an empyema, as in the former condition the fluid is sufficiently thin to be forced out through the instrument. In tubercular empyema there is frequently much coagulated serum which cannot be forced even through a large trocar.

Glycerine-formalin solution. Murphy well demonstrated that in a large proportion of cases which come under treatment reasonably early the empyema will absorb and leave the patient in an ideal condition if a portion of the pus contained in the pleural cavity is withdrawn and the following solution injected through the trocar: viz., a two per cent. glycerine solution of formalin which contains forty per cent. of formaldehyde. It is always kept ready for use so that it is never necessary to use this preparation recently mixed. This is important because in the freshly prepared solution there are always little globules of formaline which will cauterize any surface with which they come in contact, while in the mixture which has stood for a number of days the solution is perfect and this accident does not occur. From ten to sixty cc. of this solution are injected into the pus remaining in the chest cavity

after a portion of pus has been removed through a trocar to which a rubber tube at least thirty cm. long is attached to prevent the patient from filling the chest cavity with air by some sudden inspiration. The progress of the case determines the time at which this treatment is to be repeated, and the number of repetitions.

Beck's bismuth paste. Recently a number of cases have been cured by the injection of Beck's bismuth paste. Not to exceed 200 cc. of 10 per cent. absolutely pure bismuth subnitrate are injected through the canula through which the pus has been drained out of the cavity. This should be repeated every ten to fifteen days until the area of dullness begins to decrease.

The amount of bismuth injected in this manner is not sufficient to result in poisoning, but in case a patient should be uncommonly susceptible to this, it is possible to recognize the condition by the early appearance of a dark line on the gums along the edge of the teeth.

In these cases the operation of rib resection and drainage (to be described directly) should be employed at once. It is well also to fill the cavity with warm olive oil and to then permit this to drain away, as it will carry with it a quantity of the bismuth.

Anesthesia. In the presence of pus in the pleural cavity in cases not yielding to the treatment just described, an operation is always indicated. If the patient's condition does not warrant the use of a general anesthetic the operation may be performed with the use of a one per cent. solution of cocaine injected into the skin and into the sheaths of intercostal nerves a slight distance above the point at which the operation is to be done. The point to be chosen for the operation is the middle of the area of dullness, usually about the sixth or seventh rib.

Technique. An incision from two to six inches in length is made parallel with the rib in the posterior axillary line. A longitudinal incision is made through the periosteum and this is removed by means of a periosteal elevator. A pair of bone-cutting forceps, or especially devised rib-cutting forceps or shears, is then carefully applied to the rib at the posterior end of the wound; the rib is cut off, grasped by a pair of bone-holding forceps and lifted out of its periosteum to the extent to which its removal is desired. It is then cut off at this point with the bone-cutting or rib-cutting forceps. The periosteum of the rib and the pleura now lie between the abscess and the operator. If the empyema has existed for a short time only it is not necessary to remove more than one segment of rib, but if it has existed for a considerable period it is often wise to remove a portion of two or more ribs at once in order to insure a sufficient amount of space for permanent drainage, as well as to provide for a certain amount of contraction of the chest wall.

Drainage and non-irrigation. A longitudinal incision is now made through the middle of the periosteum in order to avoid the intercostal vessels and nerves. This will permit the pus to escape from the pleural cavity. It is well to make this incision sufficiently large for perfect drainage. By inserting the finger through this opening one can determine accurately the extent of the pus cavity. A long pair of dressing forceps is now passed through this opening, across the cavity explored, and its end is forced out between two ribs on the anterior surface of the chest wall at a point suitable to the conditions present. An opening is cut down upon the forceps and two perforated rubber drainage tubes at least half an inch in diameter are drawn through this opening into the chest and out of the original incision behind. They are protected by means of safety pins at each end, and after the pus has been permitted to escape a large dressing composed of aseptic gauze and absorbent cotton is applied over both openings. Neither irrigation nor

sponging is made use of. This dressing is changed as frequently as soiled, but irrigation is not practised at any time.

In large accumulations of pus in the pleural cavity, especially if there is a communication between the abscess and a bronchial tube, it is often not safe to operate with the patient in the recumbent position. In such a case it is best to aspirate most of the pus through a trocar at least two mm. in diameter or to operate with the patient in the prone posture.

Lilienthal has shown that patients suffer much less from difficulty in respiration when the chest wall has been opened when they are in a prone position. This fact can often be used to advantage after the operation has been completed. By carefully arranging the pillows so that the patient can take a comfortable position, lying prone, many recover more easily if this position is maintained.

This seems true especially in patients suffering from empyema in both sides of the chest. In these it is important to operate in two stages, the side containing the greater amount of pus being chosen for the first operation, and the second operation being postponed as long as the patient continues to improve after the first operation. If possible it is best to await the time when the drainage tubes inserted at the time of the first operation have been permanently removed. If this is not possible, however, the drainage opening on the side first operated should be covered by gauze pads spread with a handful of vaseline, producing a perfect seal, so that it will not be possible for a collapse of both lungs to take place at the same time.

A second piece of gauze with an equal amount of vaseline is kept in readiness in case of necessity to protect the other cavity after it has been opened. The operation is performed with the patient lying flat upon his chest and abdomen, and this position is maintained after the operation until he finds by experimenting that he can lie upon his side or back with comfort.

It is important in dressing these cases to take the same precautions to prevent trouble from collapse of both lungs. For this reason the wounds on only one side should be exposed, and the other side should not be dressed on the same day if there has been any disturbance of respiration during the dressing of the first wound.

We have operated only a few of these cases and it may be possible that by the use of the Melzer and Auer apparatus, or a cabinet with pressure control, one can perform the operations more conveniently, but in none of our cases did we encounter serious difficulties by following the methods just described.

In these cases, furthermore, the operation should always be performed with the greatest possible rapidity.

After-treatment. In the after-treatment it is important in the first place to secure perfect drainage, which is insured in the operation which has been described from the fact that the drainage tubes extend entirely across the pus cavity and consequently when the diaphragm encroaches upon this cavity from below and the lung from above the through drainage persists. Were there but one opening in the chest wall a pocket might readily form at some point, but with the precaution of having two openings with drainage tubes extending from one to the other this cannot occur.

It is important to make the dressing large enough to completely close the opening against the entrance of air from without and to insure this by carefully applying bandages around the dressings to hold them in the desired position.

After the discharge has been greatly reduced it is wise to begin giving the patient systematic breathing exercises. He should be directed to inhale

as fully as possible through the nose, keeping the mouth closed, and then to blow out forcibly through a tube with an aperture of about two millimeters diameter. These exercises should be frequently repeated during the day. It is well to continue in this respect for many months after the patient has recovered, because it will aid in overcoming the deformity which is sure to be present to some extent after the operation.

Danger of supervening tuberculosis. Even in cases of empyema not complicated with tuberculosis there is always a greater tendency to the development of this disease than in normal lungs; consequently these patients should be advised to live under favorable hygienic surroundings and they should be given general tonics whenever their condition of health requires. If there is any suspicion of the presence of tuberculosis anti-tubercular measures should be used for a long period after recovery from the operation. If the empyema has resulted from a traumatism, such as a penetrating wound, especially a gun-shot wound made with ordinary firearms, the infection is frequently due to the fact that some portion of clothing has been carried into the pleural cavity and consequently it is well in these cases to make the opening in the posterior axillary line sufficiently large to enable an examination of the cavity for such substances.

Continuance of the drainage. It is well to leave the drainage tubes in place until one is certain that the entire cavity has been closed down to these, because if they are left in place a little too long no harm can come from it, while if they are removed too soon a new pocket of pus may form, necessitating a secondary operation. If it seems desirable to reduce the size of the drainage tube it is well to draw smaller tubes through the entire distance so that the through drainage is maintained as long as drainage is made use of. If the granulations in the space occupied by the drainage seem flabby or unhealthy it is good practice to drop a small quantity of strong compound tincture of iodine into the cavity in order to produce a stimulating influence.

Although these cases usually progress favorably occasionally one is encountered in which healing is greatly retarded, or in which fistulæ or abscesses persist for a long time after the original operation.

FISTULA AND ABSCESSES FOLLOWING OPERATIONS FOR EMPYEMA

Although the relative proportion of persistent fistulæ and abscesses is not so great as formerly after operations for the relief of empyema of the chest, since surgeons take the same precautions as in aseptic cases to prevent secondary infection during and after this operation, they are still sufficiently common to be a source of much annoyance.

There are, of course, other elements of value from the standpoint of prophylaxis, aside from that of aseptic operation and after-treatment.

The method advised by Murphy of aspiration and subsequent injection into the pleural cavity of 60 cc. of a 2 per cent. solution of formalin in glycerine, and the plan of making tubular through drainage in case of operation instead of simply making drainage into the pleural cavity, should be mentioned especially. The former method of treatment makes the latter unnecessary in many cases, and the latter method reduces the number of persistent fistulæ and abscesses to a minimum, because it eliminates the formation of pockets.

Beck's bismuth paste. In cases in which these sinuses or abscesses persist, however, in which formerly the method of Estlander and Schede gave the most reasonable promise of ultimate success, surgical treatment has often

been most disappointing. It is just in this class of cases that the method introduced by Dr. Emil Beck has given the most satisfactory results.

The method consists in filling the sinus or pus cavity with a mixture of bismuth subnitrate and keeping this in position by plugging the outer opening with gauze. The mixture consists of one part of arsenic-free subnitrate of bismuth and two parts of sterile amber vaseline.

This mixture is injected every second day until suppuration has disappeared. The injections are repeated as often as necessary to keep the sinus or pus cavity constantly filled with the preparation. At first it is necessary to do this every day or every second day, then every third and so on until it may be necessary to inject not oftener than once a week or ten days.

We have employed this form of treatment in many cases and it shows results which are much better than those obtained previously.

One feature has been most striking. In cases that were in a septic condition when the treatment was commenced, the improvement of the general condition of the patient was especially marked. Pulse and temperature became normal within a few days and the general appearance of the patient lost the characteristics of sepsis. The nutrition improved and the anemia disappeared rapidly. The discharge from the sinuses usually becomes sterile in a short time.

To illustrate this a short abstract of the history of the following case will by typical.

An illustrative case. A. S., an Italian laborer, sixty years of age, had a pneumonia followed by empyema of the right thorax seven months ago. The pleural cavity was drained; a sinus persisted, leading into a large cavity. Three months later Estlander's operation was performed with excision of three ribs. The patient was in a severely septic and anemic condition when he entered the hospital. An injection of 720 cc. of the bismuth mixture was given and the patient put to bed. In two days 60 cc. more were injected, but by this time the septic condition had markedly decreased, and within a week the patient became normal and his anemia began to disappear. For one month injections were made every second day, the quantity in the meantime decreased to 35 cc. and the patient acquired a rosy appearance. Then he was sent home,—at first, to return twice a week to have a few cc. injected, and later only once a week, a sufficient amount being used each time to fill but not to distend the cavity.

Nine months later his general health was perfect and there was but a superficial sinus which held scarcely 5 cc. of the paste, and which would undoubtedly heal completely in a short time.

A second case seems worthy of special description because it is one of those that were formerly extremely difficult to heal.

F. C., American, age thirty-five, miner, had a severe fall nine months ago while working in the mountains; this was followed by pneumonia and then by a right-sided empyema. This was drained through a rib-resection opening. Seven months later an Estlander operation was made, with resection of three ribs. At the end of two months the patient came under our care. At this time there was a sinus discharging pus freely, and the patient coughed up the same material. This was before we were familiar with the bismuth paste treatment—so we performed Schede's operation. The patient did well for nearly a week, when he developed a phlebitis in both femoral veins. He became markedly septic and emaciated. Four weeks later he still expectorated pus, and there was a free drainage of pus from the wound when we began the injection of No. 1 bismuth paste. He expectorated much of the 650 cc. of the paste injected. The injection was repeated, each time simply filling the cavity without using any force. The pus and sepsis subsided rapidly. In ten days he appeared like a different person, and in twelve weeks he was perfectly well.

Conclusions and further details. This treatment has proven most satisfactory. We have used it only in cases with sinuses, although it has been suggested to aspirate the pus in empyema and to inject the paste into the pleural cavity through the trocar.

There has been no case of bismuth poisoning in our series of cases, although this might easily occur—as it has when cavities in other portions of the body have been filled with large quantities of bismuth paste. If this occurs, Beck advises the immediate injection of hot olive oil, 110° F., which will dissolve the paste and facilitate its escape through the outer fistula or through a drainage tube, which may be inserted.

The injection is made with a large, ordinary glass syringe, just enough force being employed to fill the sinus or cavity, but not enough to cause forcible distension. The outer opening is carefully plugged with sterile gauze.

In a few cases of empyema, accompanied by tuberculous cavities of the lung, in which the patient came under treatment in a severely septic state, with a communication between the sinus and the cavity in the lung, so that the patient would expectorate the bismuth paste after injection, we have had remarkable improvement.

The paste seemed to result in a disinfection of the sinus and cavity so that the symptoms of acute sepsis disappeared, which gave the patient an opportunity once more to collect some strength to withstand the tuberculosis.

CHRONIC EMPYEMA

Conditions favoring this disease. The drainage, followed by the use of Beck's paste, of an empyema of the chest does not always result in the complete cure of the empyema. This may be occasioned:—

1st. By the contraction of the lung to such an extent as to leave a considerable space which is not filled by re-expansion.

2d. By the unyielding condition of the chest wall.

3d. By the fact that there are sometimes a number of abscesses separated from each other by adhesions between the pulmonary and the costal pleuræ. It happens occasionally that only one of a number of these abscesses is opened, and then the drainage of that focus can, of course, not relieve the other abscesses. Frequently there are small sinuses communicating between the different pus formations so that there is a constant flow from an undrained abscess into the drained one; or this communication may from time to time become obstructed and then the drained abscess will approach complete healing only to have a new discharge of pus into it from its undrained neighbor. In such instances it is usually possible to locate the other abscesses by means of percussion.

Again the healing may be prevented because of the inelasticity of the thickened pleura which prevents it from applying itself to the surface of the lung. It frequently happens that the costal pleura is several centimeters in thickness. There may also be a necrosis of one or more ribs secondary to the pleuritic infection, which may again account for the fact that healing does not take place. In still other cases there is a constant reinfection from a tubercular abscess in the lung which perhaps did not directly communicate with the empyema at the time of the operation. All of these conditions, with the exception of the last one, can be relieved by a proper operation, which must have in view the application of the chest wall, or what is left of it, to the surface of the lung.

Technique. The operation to be chosen must depend upon the extent and location of the empyema. If this is confined to the lower portion of the chest cavity an excision of a number of ribs, beginning with the seventh, eighth or ninth and going upward until the upper edge of the empyema is reached, will usually suffice. The thickened pleura should be removed at the same time. The intercostal arteries should be ligated in this operation even

though no hemorrhage takes place at the time of the operation, or they should at least be crushed with clamp forceps because they frequently begin to bleed after the patient has recovered from shock, unless they have been properly disposed of.

If the empyema extends up to a point above the level of the lower angle of the scapula then it is usually wise to make a large flap of the chest wall with its base upward, cutting through the skin, the muscle, the ribs and the pleura, and cutting away a sufficient portion of the rib ends to permit this flap to sink into the cavity. Here again the intercostal arteries should be cared for. It is usually wise to apply a large tampon composed of aseptic gauze to the entire cavity and to lay the large flap which has thus been formed upon the surface of this tampon and then to apply a large dressing over it. This tampon is left in place for a sufficient length of time to stimulate the growth of vigorous granulation tissue over the under surface of this flap as well as over the surface at the bottom of the cavity. After the tampon has been removed the flap is placed in this cavity and permitted to heal in place. In this operation again it is often wise to excise a thickened pleura. If the condition is due to the presence of necrotic ribs these should be removed. If it is due to a reinfection from a tubercular lung either of the methods which have just been described may be used, but they are usually not followed by a complete recovery. Occasionally it seems best to treat a chronic empyema by laying the cavity widely open by one or the other of the methods just described, to apply a large tampon to the cavity thus exposed and to reduce this tampon slowly until the entire cavity has healed from the bottom. In chronic empyema we should say that the most important point consists in making the operation thorough enough.

Even after this operation sinuses sometimes persist and these should then be treated by the injection of bismuth paste after the method described above. In our recent experience the results have been very good even in the cases which formerly appeared almost hopeless.

OPERATIVE TREATMENT OF UNILATERAL LUNG TUBERCULOSIS BY TOTAL MOBILIZATION OF THE CHEST WALL, BY MEANS OF THORACOPLASTIC PLEURO-PNEUMOLYSIS

The many attempts by surgical means (by injection, opening of the cavity formed, or by resection of the rib, and part of the lung) to cure pulmonary tuberculosis have proven very unsatisfactory because the slow course of healing makes it a relatively hopeless process.

Murphy, Forlanni and Brauer by artificial pneumothorax caused compression of the lung tissue with reduction of size of cavity and immobilization of the affected lung tissue.

Brauer states that adhesions occur in one-fourth of all cases of pulmonary tuberculosis, therefore, nitrogen, if introduced between the pleuræ, is an impossible procedure in a large majority of cases. Other methods of reducing the volume of the lung and shrinking of cavities in the lung tissue have been attempted.

Brauer advocates loosening of adhesions by surgical interference, and then reducing the volume of lung by introduction of nitrogen between the layers of pleuræ. Friedrich objects to this method because the pleura remains thin in spite of adhesions, and during manual separation without aid of sight there is exceedingly great danger of tearing the lung tissue. Also because of the following complications: Empyema of the pleuræ, mediastinitis, which markedly endanger the patient's life.

Friedrich speaks of a case in which there was a large cavity, which, on draining of mild serous pleural exudate, became an extensive pleural suppuration, terminating fatally in a few weeks.

FRIEDRICH'S METHOD FOR MOBILIZATION OF CHEST WALL BY MEANS OF TOTAL REMOVAL OF BONE WITH PRESERVATION OF PLEURA COSTALIS

In young individuals the operation has a tendency to produce marked shrinking of the lung on the side on which resection is done and drawing the opposite lung, heart, mediastinum, diaphragm and clavicular fossa toward the shrinking lung, which produces hindrances in the process of recovery.

For this reason efforts should be directed to prevent this tendency of shrinking of an extensively involved lung. This difficulty is overcome by extensive rib resection if the chest cavity is allowed to be closed.

Although most patients have fever and considerable expectoration, no antipyretics or expectorants are given, but efforts are used to increase appetite and to improve the gastro-intestinal functions.

Confine patient to bed—give definite physical and X-ray examination.

Technique. On day of operation, nothing by mouth except a cup of tea in the morning. Twenty minutes before the operation give hypodermic of .015 to .02 morphine muriate.

After this and before the anesthetic is commenced all possible expectoration is encouraged for a long time to free the bronchi and caverns of secretion and diminish danger of aspiration during the anesthesia.

Place the patient in a semi-oblique position with the body turned half over on well side with the arm held vertically up in the air.

Disinfect the surgical field very thoroughly with soap, ether and alcohol.

Incision is made similar to that in Schede's method of thoracoplasty in empyema, the muscle being rendered analgesic by Schleich's infiltration method. Then a flap is formed by beginning the incision three fingers' breadth external to edge of the sternum at the height of second or third rib; it is carried downwards external to the nipple to the tenth rib, posteriorly up again to the second dorsal spine. The line of incision is varied occasionally for cosmetic reasons.

In dividing the serratus magnus muscle the ends of the serrations are allowed to remain, otherwise the whole muscle with the vessels and nerves is rapidly displaced upward. The pectoralis major and latissimus dorsi are deeply niched and drawn strongly aside with retractors.

The bony chest is now all exposed. Then with greatest rapidity, the ribs are resected, leaving periosteum and intercostal muscles behind, being, however, all the time careful not to puncture the pleura costalis, as a pneumothorax at the present stage would greatly endanger the patient, as a marked increase in secretions of the caverns would greatly promote suppuration. This accident is very much more easily avoided by using the positive or negative air-pressure apparatus of Brauer or Sauerbruch.

After detachment of the second to tenth ribs from the anterior cartilages to the spine, and especially after the attachments of second and tenth ribs gives way, the whole lung covered by the intact pleura costalis sinks back toward the hilus, and in operations on the left side, the heart can be seen rising above the level of the lung surface. By practice such rib resections as these—removing in all 180 to 220 cm. of bone—can be done in twenty-five minutes.

After removal of projecting pieces of intercostal muscles, nerves and periosteum, and careful hemostasis, the flap of muscle is carefully approxi-

mated with twenty to thirty buried catgut sutures. Skin sutures with silk are applied and a thick drainage tube is inserted along the spine.

Little general anesthesia required. As a rule, if all these conditions are carefully attended to during the operation the patient should have a good pulse on leaving the table. Inhalation anesthesia is only necessary when rib resection proper is commenced, provided morphine and infiltration anesthesia has been previously used. The anesthetic is given in restricted amount so that bronchial and laryngeal reflexes remain, in order to facilitate expectoration, while pain is not felt. An experienced anesthetist can do this with 5 to 15 gms. of chloroform.

The heart-effect. A mildly compressing aseptic dressing and bandage is applied and patient put to bed in a prone-oblique position. The most important factor during the following hours and days is the behavior of the heart, which on account of change in volume has suffered more or less dislocation in position and with the collapsed lung it is subjected to pressure of the air on the opposite side.

The preservation of the costal cartilages is important in preventing dislocation from acting too much upon the heart. The disturbance in the heart action is similar to that found associated with severe contusion of the thorax and known as delirium cordis, characterized by increased rate, diminution in size, and absence of pulse. If the heart is energetically stimulated with digitalis intravenously, caffein and camphor and normal salines subcutaneously, the patient is usually brought safely through the dangers.

The course of wound healing is usually smooth. In six to ten days the drainage tube is removed, and healing by primary union is obtained.

Dyspnea is the rule during the first few days following the operation, due to the fact that the lung on the opposite side has to do all the work for both, besides being interfered with by pressure of the air on the opposite lung and the heart. This disappears in a few days.

As the wound pain disappears expectoration recurs and is facilitated by pressing the hand against the immobolized side, thus aiding the removal of the contents of the caverns.

The temperature and amount of sputum fall rapidly as soon as expectoration has begun.

In unilateral pulmonary tuberculosis, fibro-cavernous in type, occurring in young and middle-aged persons, with various degrees of fever, and in which climatic, dietetic, and medicinal measures have been of no avail in staying the progress of the disease, the operation is indicated.

The degree of temperature and amount of sputum have no influence in the indications.

(Be conservative in cases of multiple tuberculosis, especially if associated with intestinal tuberculosis.)

The danger of the operation lies in the increased demands upon the heart.

ARTIFICIAL PNEUMOTHORAX

During the past five years the brilliant suggestion made by Murphy twenty years ago to employ artificial pneumothorax in the treatment of pulmonary tuberculosis has received much attention, especially in the United States and in Germany. It has been used very successfully in many suitable cases by Dr. Ethan A. Gray, medical superintendent Chicago Fresh Air Hospital, who has kindly given us the following description of this treatment.

[**Definition.** Artificial pneumothorax is the presence of an innocuous gas, introduced into the pleural cavity as a therapeutic measure. The therapeutic application of lung compression depends on the fact that tubercular

processes of even severe grade are often influenced favorably by the compression produced by pleural effusions. Spontaneous pneumothorax, also, has often shown marked, though temporary improvement of the collapsed lung.

Indications. Artificial or induced pneumothorax is indicated, strictly speaking, in unilateral tuberculosis of the lung. In fact the patient must have one good, functionating lung, else he cannot safely submit to collapse of the other. Rudolph Brauer and his school maintain that, before lung collapse is indicated, all other therapeutic measures must have been tried and found wanting. Experience in over one hundred cases treated at the Fresh Air Hospital by this method shows that patients who have failed to improve after a more or less lengthy "cure" by medicinal, climatic and hygienic means, have had so many pleural adhesions that it was not possible to produce a collapse of the lung. Again, the late case has too often become actively bilateral, and much bilateral disease is a contra-indication to artificial collapse. The early collapse of the diseased lung is easy and is usually brilliant in its results. Early collapse of a cavernous lung stops the advance of the disease and checks toxemia by compressing the lymph-spaces. Temperature and pulse frequently drop rapidly to the normal; sputum, at first more profuse, becomes scanty and ultimately ceases; cough diminishes. Later, the diseased portions of the lung tissue cicatrize and thus heal.

Hemorrhage constitutes an imperative indication for artificial pneumothorax, regardless of existing disease in the other lung unless such disease be in itself a menace to life. High temperature may be regarded as a strong indication for lung collapse if the disease be confined to one lung.

Contra-indications. These are active bilateral pulmonary disease; heart disease; serious disease of any other vital organ, pneumoconiosis.

Apparatus. The writer uses the original Murphy type of apparatus, controlled by a manometer devised by himself. The apparatus consists of a copper cylinder which holds the nitrogen gas under pressure, a gas container (100 cc.), the manometer and a blunt (45 degree) point, 18-gauge aspirating needle, all properly connected by rubber tubing; for re-insufflations a sharper needle is used.

Technique. Before proceeding to operation it is wise to have had the patient under observation in a hospital for at least thirty days. The information thus collected will be of great importance.

To determine the proper location of the proposed puncture, careful study of the chest by inspection, percussion and auscultation is necessary.

Inspection. Litten's sign, intercostal retraction.

Percussion. Normal or near normal note, tympanic note of cavity of stomach; dullness of thickened pleura, downward excursion of lung, consolidation.

Auscultation. Rales close to stethoscope, cavernous respiration.

The Roentgen plate is of little or no value in this connection. We rely most on the nearly normal percussion note, while distrusting auscultatory sounds of especial clearness.

The Roentgen screen is of value after insufflations and before refillings. It gives information as to the completeness of collapse, action of adhesions, etc.

One should be on guard against puncturing in the vicinity of the great vessels; the insertions of the diaphragm should also be borne in mind.

After the patient has been examined sitting, he should be again examined lying on the table, a hard roll or cushion being under the thorax so that the intercostal spaces will be separated, and the site of puncture raised. The point of puncture being determined, the skin is painted with tincture of iodine and a very small incision, not more than two or three millimeters long, is made through the skin. After the slight bleeding has ceased, the

blunt (18 gauge, 45 degree) needle is carefully passed through the wound and pushed through muscle and fascia, until the parietal pleura gives way with a dull but audible sound; this seems to the operator to be felt rather than heard. (This produces but slight pain and does not require even local anesthesia.) As soon as the needle has reached the free pleura, the fact will be indicated by a rise in the near column of the manometer. If no movement results from the puncture, the needle has not found the pleural sinus, or else it may be stopped up with a drop of blood or with a shred of flesh. If no manometric variation results, the needle should be withdrawn for examination. If clear, it may be again introduced in the attempt to find the pleural sinus. *Not before the manometer establishes the certainty that the needle is in the pleural sinus, should the gas be turned on.* The patient must be *warned not to breathe deeply!* After the rise in the near column has appeared, the nitrogen is allowed to flow until 50cc. has been taken; it is now turned off and the manometer observed; this will usually show a quick rise to the same negative point as at first. At the first operation it is usually safe to give 400 to 600 cc. of nitrogen, stopping with negative pressure. Exception to this is allowed in the case of hemorrhage, when a large amount of gas is needed to compress the bleeding lung. Should the patient complain of fullness or of continued pain, or of other distress, or should the manometer show positive pressure, the operation should be terminated. The needle is now withdrawn, and the small wound sealed with collodion, and a retaining adhesive strap applied. (Some operators use no dressing and their results are equally good.) The patient should now be kept quiet for twenty-four hours and should be instructed not to exert himself in any way; e. g., bending over, laughing, straining at stool, etc. Coughing must be controlled. Re-insufflation is done in two days, and thereafter as often as the nitrogen is seen to be absorbed. Later the inflations are performed as seldom as four to six weeks apart. For hemorrhage the lung should be kept *closely* collapsed for ten to fourteen days after pneumothorax is produced; the pneumothorax should be maintained for six months. If the first puncture proves to be a failure, it is permissible to make one or two more attempts at the same sitting. Careful study of the chest sometimes reveals a more favorable site for puncture.

Complications and dangers.—Air or gas embolism. This accident is caused by the entrance of a quantity of gas into a vein. If the bubbles of gas are carried into the vital centers of the brain, death occurs in a short time. Phenomena of gas embolism, as observed by European operators, are sudden dizziness and loss of consciousness; frequently Jacksonian convulsions, hemiplegia, cutaneous congestion, respiratory failure, death.

Embolism may occur in either the primary or in the later insufflations. It is said to have occurred even when the strictest precautions have been observed.

A study of the mechanism of air embolism has given rise to certain important rules:

1. Never urge the patient to breathe deeply in the search for the pleural sinus.

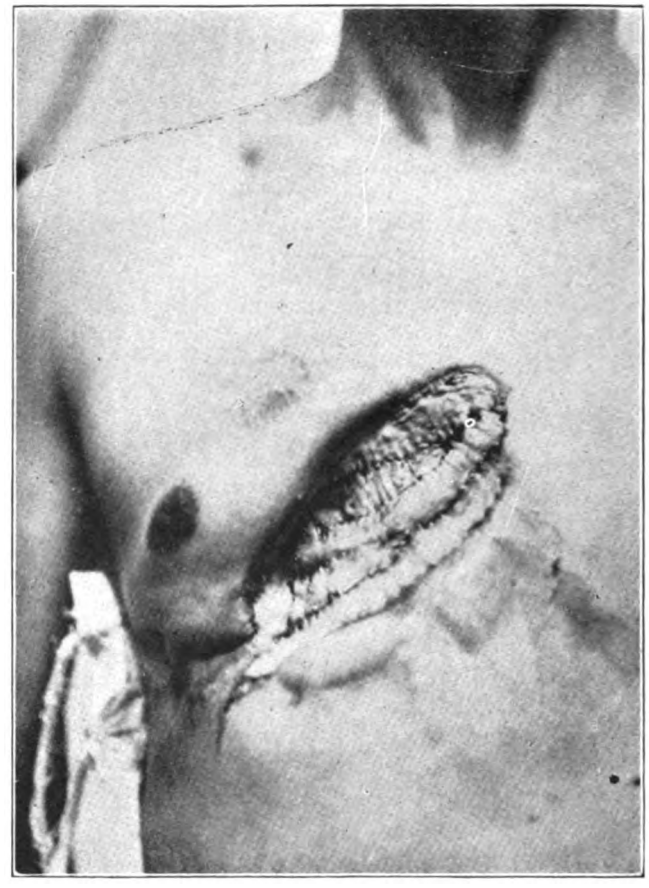
2. Never turn on the gas before the manometer shows by negative pressure indication that the needle opening is in the pleural sinus.

3. Always operate on the recumbent patient, the point of puncture being uppermost. (Saugmann suggests that air bubbles will have difficulty in reaching the lower-lying brain, thus diminishing the danger of embolus. Be this as it may, my own experience in nearly 900 insufflations without accident, all made on the recumbent patient, would seem to bear out Saugmann's idea.)

4. Never move the needle about in the wound. If the sinus is not found after slowly introducing and withdrawing the needle, and the lumen of the latter be found clear, the attempt should be given up at that point, and perhaps for that time.

Embolus has occurred before the gas has been turned on, the gas in the tubing having been sufficient to cause the accident.

Emphysema. This occurs within a few hours of the operation and may be painful and uncomfortable but it is in no wise dangerous; the gas may

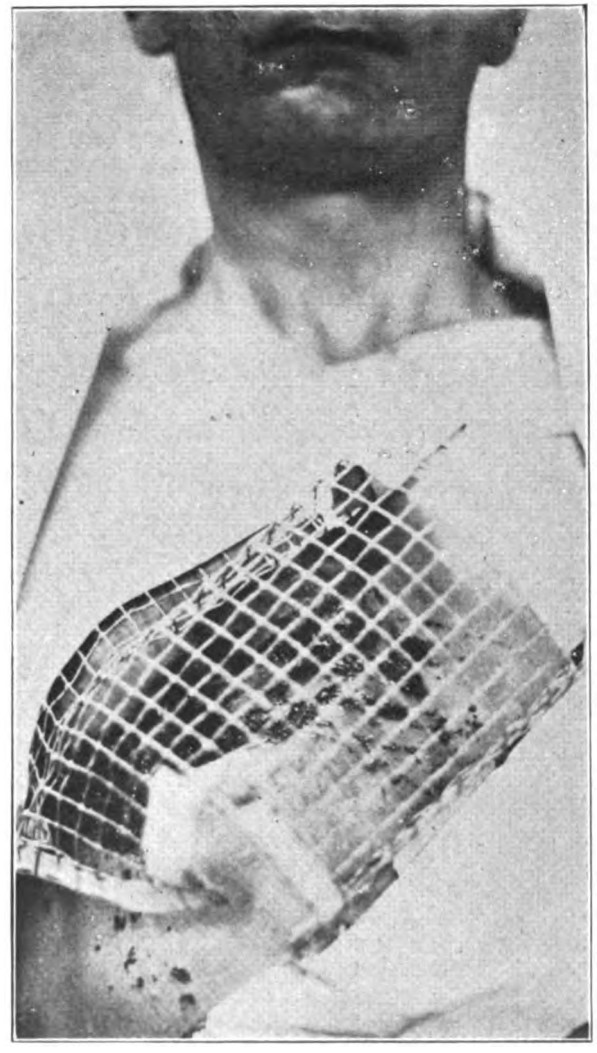


A Large Ulcer of the Chest Wall Arising from Typhoid Osteomyelitis of the Ribs. Treated by Dressings of Dakin's Solution and Finally by Thiersch Skin Grafts, which Are Shown in Place in the Photograph.

infiltrate the subcutaneous tissue over the whole side, down to the hip, up the neck and down the arm. It absorbs in a few days.

Over-inflation. This manifests itself by rapid heart, dyspnea, difficult deglutition, due to pressure on the gullet and by extension of the pneumothorax to the opposite side of the sternum and spine. A hypodermic of morphia (gr. $\frac{1}{8}$) will quiet the situation for a few hours, by which time the organs will have adjusted themselves and some of the gas will have absorbed. If the patient's condition becomes alarming it is a simple matter to withdraw some of the gas.

Pneumonia. This or any other serious complication in the "good" lung calls for abandonment of the collapse treatment. It may even be necessary to deflate the pneumothorax in order to relieve the patient's respiratory embar-



SHOWING HOW THE SKIN GRAFTS ARE PROTECTED BY WIRE NETTING.

rassment. I have seen a pneumonia patient recover under these circumstances. Broncho-pneumonias, particularly after hemorrhage are usually fatal.

Prognosis. This depends on the stage and condition in which the case is when taken for treatment. If one selects those in whom there is no hint of bilateral involvement, or those whose disease is not far advanced, the results will be most satisfactory. If cases are selected which require careful watching, which are likely to have lighting up of foci in the other lung, fewer will show such complete cures as those in the previous category.

Again, cases which receive gas in an *ultimun refugium*, will not be fruitful of good results.

In the first and second groups many patients will be cured and returned to work. In the last group, life will be prolonged; exacerbation of disease often occurs in the other side and ends any further attempts with pneumothorax.

Our experience with patients of all disease types at the Fresh Air Hospital, convinces me that:

(a) Pneumothorax should be practised early.

(b) It should be offered to the suitable, far-advanced cases on the chance of saving one here and there.

Ability to work. The patient with a collapsed lung is able to do considerable work. For example, we have our patients working as chauffeur, elevator conductor, stationery engineer, painter, delivery driver, house-keepers, clerks, railway conductor and others.

Duration of treatment. This varies; some cases do well with a collapse maintained only a short time (six months), others require treatment of a year to two years. Saugmann reports a case of a woman who returned for her gas during six years. Expansion of the lung and gradual obliteration of the pleural sac occurs in a fair percentage of cases and thus automatically terminates the treatment. Many of these cases, so terminated, do very well.]

TUBERCULOSIS OF THE RIBS

This condition may occur primarily or secondarily. In either case it results in abscess formation and later in the formation of sinuses leading down to diseased bone. It is occasionally possible to secure healing by making a free incision over the middle of the diseased rib reflecting the periosteum and curetting away the diseased tissue, but usually nothing short of excision of the rib will suffice.

ACTINOMYCOSIS

The positive sign. In the United States empyema caused by an infection with the ray fungus is not so very uncommon and should constantly be borne in mind as one of the possibilities, especially as the treatment must be entirely different in case actinomycosis is present. This condition can be recognized by the presence of little yellowish flakes in discharge from the empyema which contain the characteristic ray fungus, easily demonstrated by microscopical examination.

The curative value of potassium iodide and the dosage. In cases suffering from actinomycosis it is important to bear in mind the fact that this disease is curable by the administration of very large doses of iodide of potash. Small doses are of little benefit. It seems necessary to saturate the blood thoroughly with this drug in order to destroy the parasite. The method which we have found most useful consists in the administration of sixty to ninety grains of iodide of potash in a glass of warm milk, followed by a pint of hot water, three times a day, preferably at 6 a. m. and at 2 and 10 p. m., in order to have the periods eight hours apart. In this way the drug may be given in these large doses without causing any marked disturbance. It is used for three days in succession; then the patient is permitted to rest for quite one week, after which the administration is again repeated. After about six weeks of treatment these cases usually recover perfectly unless an undrained abscess be present. In such event some of the parasites seem to remain where the drug does not reach them and from that point reinfection may take place; consequently it is wise to repeat the treatment a number of times after permitting the patient to rest for a month or two, when he has arrived at what is considered a complete cure. This precaution is especially needful in patients who

live at a distance so that they cannot be kept under observation conveniently. We lost one patient evidently because this precaution was neglected. In a second case in which the disease was located in the neck the patient returned after one year with a recurrence, complicated with an edema of the larynx which nearly proved fatal. Renewed treatment with ninety grains of potassium iodide again relieved the patient, who has now been well for ten years. After being apparently well the remedy was given for three days each month for six months.

Purity of the drug. It is to be borne in mind that small doses of potassium iodide are absolutely useless in the treatment of this disease. Furthermore, it is of the greatest importance to use a preparation of potassium iodide which is absolutely pure. Most of this drug as obtained in the market seems not to be perfectly pure, and while in our experience ninety grains can always be given when the pure drug is used many patients cannot take even much smaller doses of the ordinary drug.

ABSCESS OF THE LUNG

Physical signs. Following pneumonia or an infection, such as puerperal, in some other part of the body, an abscess in the lung not connected with the pleural cavity may occur. This may communicate with a bronchus and may evacuate itself thereby from time to time, or it may remain circumscribed within the lung tissue. It is relatively easy to recognize this condition if the abscess cavity communicates with a bronchus, because its filling and emptying can be observed. If it is near the costal surface of the lung it may be recognized by percussion, giving much the same sound that is obtained upon percussion over the surface of the liver. If the abscess is not at the edge of the lung resonance will be observed above, below, and to each side of it, giving the impression of a circumscribed space filled with fluid. Its presence usually gives rise to an abnormal temperature, which frequently reaches 104, 105 and 106° Fahrenheit.

In the more serious cases a considerable portion of one lobe, or the entire lobe, may become gangrenous from the presence of an infarct.

One of the larger vessels may be completely obstructed by a thrombus so that a considerable portion of lung tissue becomes necrotic. In these cases there is always a very marked odor as soon as the products of this decomposing lung tissue are expectorated. The expectorated material usually has the character of thin, sanguineous pus, which is quite characteristic.

Danger of lung collapse and its prevention. The rational treatment must, of course, consist in the evacuation of the abscess externally. There is, however, one great danger in this operation resulting from the fact that in order to approach the abscess the pleural cavity must be opened, and if an adhesion does not exist between the pulmonary and the costal pleura the lung is likely to collapse. This condition frequently results in the death of the patient, and in order to guard against it the surgeon should be prepared to inflate the lung through a tube inserted into the larynx, constructed so that its end will fit tightly between the vocal cords. Its top should be connected with bellows by means of which the collapsed lung may be inflated. The apparatus known as the Fell-O'Dwyer is very simple and efficient, and this, or some other positive pressure apparatus should always be procured whenever the operation here mentioned is undertaken.

Technique. A U-shaped incision should be made over the area covering the abscess and the flap turned back, exposing two or three ribs. Portions four inches in length of at least two ribs should be resected with great care, in order not to penetrate the costal pleura until sufficient space has been

secured to repair the mischief which might occur from the sudden collapse of the lung. After this area has been laid bare the portion of lung opposite may be grasped by means of fine volsellum forceps through the costal pleura, or fine stitches of catgut may be passed through the costal pleura and the adjoining lung at several points, or an apparatus for inflating the lung may be applied and the lung filled with air by compressing the bellows, and then the costal pleura may be opened and the lung sutured to this opening, or it may be sutured to folds of iodoform gauze which are drawn over the edge in the opening in the costal pleura so that the lung cannot be retracted.

A method which has been very satisfactory consists in suturing with catgut pieces of wet gauze to the parietal pleura and lung around the edge of the opening before the pleura is opened; the moist gauze prevents the entrance of air and consequently pneumothorax cannot occur. The abscess is then best entered by means of the actual cautery, because the opening thus made will enlarge when the eschar caused by the burn becomes separated.

Upon introducing the finger into this cavity bands will be found to pass through it which the surgeon atempts to break down in order to reduce the entire space into one cavity. These bands frequently contain large blood vessels and it is consequently best to apply hemostatic forceps to them and to cut between these. The cavity may be drained by inserting a few strands of gauze; then the wound is dressed as in the operation for the relief of empyema.

In case the abscess of the lung approaches the pleura, adhesions between the pulmonary and the costal pleuræ have usually formed so that there is no danger from the formation of pneumothorax, but it is never safe to operate in these cases without being prepared to find no adhesions present. Here again a large dressing is indicated, and it is wise not to permit the external wound to heal too soon after the operation.

GUNSHOT AND STAB WOUNDS OF THE CHEST

Hemorrhage. In the treatment of gunshot or stab wounds of the chest it is, first, important to determine whether there is dangerous bleeding from the intercostal vessels or from the internal mammary artery. The former can easily be exposed, clamped and ligated. The latter, being located near the sternum between the costal cartilages and the pleura, is in a position in which it is difficult to ligate without fear of causing pneumothorax by opening the pleura. The fact that this vessel is given off from the subclavian artery makes the hemorrhage very formidable, and the further fact that it is located behind the costal cartilages makes a hemorrhage into the pleural cavity more likely than an external hemorrhage. In case of bleeding from the internal mammary artery it is necessary to remember that the costal cartilage can be easily cut with an ordinary scalpel and that the external wound is of no importance, consequently a large external wound should be made over the costal cartilage of the next rib above the point of injury, this cartilage should be carefully cut away for a distance of at least an inch over the point at which it crosses the artery, and then a fine stitch should be passed around the artery and tied. The danger from trying to perform this operation through a small external wound is very much greater than it is if ample space be secured by making a large one.

The hemorrhage from these two sources having been disposed of the next important point is to secure, as nearly as possible, complete rest of the chest walls. This can best be accomplished by applying a plaster-of-Paris jacket extending from the lower border of the ribs up over both shoulders. The patient will immediately begin to breathe by using the diaphragm alone and the irritable hacking cough will in most cases subside, and therefore the

patient will stop pumping blood from the lung tissue into his pleural cavity. If empyema follows through an infection caused by the injury it should be treated according to the method which has already been detailed.

Do not probe: Apply chest splint. This point should be borne in mind above all things—that under no conditions should a wound of the thorax be examined with a probe, because probing is one of the chief sources of infection. If plaster-of-Paris is not available, or if the patient does not seem sufficiently strong to bear its application, a protecting cast may be constructed in a few minutes by winding long strips of rubber adhesive plaster, from two to three inches in width, about the entire chest, beginning at the border of the ribs and working upwards until the whole chest and shoulders are covered. Several layers of this plaster may be applied to advantage. It is surprising how quickly a patient who has not been able to rest for a moment on account of the irritation due to the motion of his chest walls, will become quiet and fall asleep after one or the other of these jackets has been applied. Cases which have so far advanced that the danger of new hemorrhage is over, but in which the blood in the pleural cavity is not absorbed, should be aspirated through a trocar or drained by open incision or treated like an empyema.

Value of the chest splint. The same treatment with rubber adhesive plaster strips acts quite as beneficially in patients with severe injury to the ribs due to contusion A man sixty-two years of age was caught under an upturned vehicle and rolled between the ground and the vehicle, resulting in a number of ribs being broken at various places. When we saw him at his home twelve hours later his pulse was imperceptible, he was severely cyanosed and only with great difficulty could he gasp for a little air. He was almost unconscious from exhaustion although his head had not been injured. As soon as the rubber adhesive plaster cast had been applied the patient began to breathe regularly and quietly, although, of course, entirely with his diaphragm; his pulse came back, beating 180 per minute. Within an hour it had been reduced below 100 per minute. He became perfectly conscious at once and made a thorough recovery. We have seen many similar though less severe cases.

PNEUMOTHORAX

If the wound in the chest wall has been sufficient to admit a quantity of air the lung will become compressed and a pneumothorax will be formed. All that is required for the relief of this condition is the closure of the external wound, unless there has been a complete collapse of the lung, in which event the lung should first be distended by means of inflation before the opening in the chest wall is closed, or the opening may be closed and the air contained in the chest cavity may be aspirated by a pump through a trocar. If, however, air is forced into the pleural cavity from the lung itself by the injury of the lung tissue then it may become necessary to make a rib resection, to grasp the injured point of the lung with forceps to draw it to the external wound and there to attach it, after the manner described in the operation for abscess of the lung. The wound in the lung, however, is usually so small that it closes spontaneously, or it is so large that the patient succumbs before the surgeon has an opportunity to secure relief by an operation.

The Fell bellows. Dr. George Fell has invented a form of negative pressure bellows attached to a bell which can be placed over the opening in the chest wall and by means of which a vacuum may be secured which will immediately remove any air that has entered the chest cavity through an opening in the chest wall. This vacuum can be maintained indefinitely until the wound in the chest wall has closed spontaneously, or sutures may be inserted before the air-pump has been applied, and when all of the air has been withdrawn from the

pleural cavity these sutures are drawn tense and then tied, thus permanently closing the chest cavity against recurrence of pneumothorax.

The Sauerbruch cabinet and other methods. Many other forms of apparatus have been invented during the past few years for the purpose of controlling especially that form of pneumothorax that is produced intentionally during operations upon intrathoracic organs. This idea was brought forward successfully and effectively first by Sauerbruch, who introduced a negative pressure cabinet in which the surgeon and the body of the patient was placed while the patient's head projected into the outer air through an opening lined with a perforated rubber sheet, the perforation fitting snugly about the patient's neck. By pumping air out of the chamber containing the body a sufficient negative difference of pressure could be produced to cause the air which entered the lungs through the trachea at a higher pressure to distend the lungs to a sufficient extent to prevent the formation of pneumothorax when the chest wall was opened. The degree of pressure can be accurately controlled by an assistant.

Brauer produced the same effect of overpressure by leaving the body of the patient in the atmosphere of the operating room and placing the head in a cabinet into which air is being pumped in sufficient quantity to produce a sufficient degree of pressure to prevent the formation of pneumothorax when the chest wall is opened. Robinson has perfected a most excellent apparatus for the same purpose, in which the cabinet containing the high pressure air is sufficiently large to accommodate the anesthetist at the same time. Willy Meyer has produced a still more ingenious apparatus that can be changed from a negative to a positive pressure, and *vice versa,* in a moment.

All of these forms, however, are extremely expensive and complicated and only available in large institutions.

The same overpressure effect has been produced by Fell with an extremely simple mechanism that may be obtained at a very small cost and which has been used in a large number of cases with absolutely satisfactory results. It consists of a compound bellows furnishing a uniform stream of air which is forced into the lungs through an accurately fitting mask applied over nose and mouth, or through an intubation or a tracheotomy tube. Melzer and Carrel have produced the same result by pumping air into the lungs with ordinary bellows through a catheter filling the trachea to two-thirds of its size and extending almost but not quite to the bifurcation of the trachea.

We have seen all of these methods in use but have used only the Fell apparatus in our own practice and its simplicity and effectiveness has impressed us strongly in its favor. Theoretically, however, there seems to be no doubt but that the apparatus of Willy Meyer is at the present time the most perfect for the control of pneumothorax during intrathoracic operations.

The chest wall in all of these cases must of course be definitely closed before the apparatus is discarded after any of these operations.

HYDROTHORAX

Hydrothorax is so easily recognized by physical examination that it is scarcely worth while to discuss it. It is so common in its occurrence that it rarely reaches the hands of the surgeon. The accumulation of fluid in the pleural cavity may absorb spontaneously or it may be withdrawn by aspiration. Only a part of the fluid should be withdrawn at one time. Many authorities prefer to withdraw but a few ounces and to depend upon absorption for the removal of the remaining portion, which usually occurs after a few ounces have been aspirated. Other surgeons prefer to remove a considerable pro-

portion of the fluid. There is no doubt but that it is wise never to remove the entire amount present.

TUMORS OF THE CHEST

Of tumors of the chest which are interesting in a surgical way only those due to the presence of hydatids, actinomyces and syphilis, and dermoid cysts, need to be mentioned. Sarcomata, carcinomata and endotheliomata occur but are not interesting surgically (i.e., call for no particularly different form of treatment) except from a diagnostic standpoint. Hydatid cysts most frequently occur through perforation of the diaphragm on account of infection from hydatids of the liver. This condition is treated in the same manner as empyema. Actinomycosis has already been discussed. Gummata are treated by means of internal medication if the condition is recognized. Dermoid cysts are enucleated, the same precautions being taken to prevent collapse of the lung that were described in connection with the treatment of pulmonary abscess.

Lympho-sarcomata are of especial interest because their usual location about the diaphragm makes the differentiation between this condition and empyema difficult at times.

MEDIASTINAL ABSCESS

This affection is recognized by the symptoms of weight and pain in the retro-sternal region. The pain is increased especially upon drinking, coughing, and upon pressure. There is frequently a swelling over the surface of the sternum. The condition is treated, when diagnosed, after the same manner as abscesses in general. An opening is cut in the sternum and the pus permitted to evacuate. The cavity is then drained by means of strands of gauze carried to the bottom of the abscess.

TUBERCULOSIS OF THE STERNUM

The sternum may be removed in part or entirely for tuberculosis, precisely as one would remove a tuberculous rib. If possible the costal attachment should not be disturbed. The operation is not especially dangerous, because there is in these cases a sufficient support on account of the presence of connective tissue which has formed behind the sternum as a result of the long-continued inflammation which preceded the destruction of this bone.

INFECTIONS OF THE MAMMARY GLAND

Methods of production. These occur most commonly through abrasions of the nipple during nursing. The mouth of the child may contain the infectious micro-organisms or they may be upon the surface of the nipple when the child is applied, or fissures may occur and the staphylococci which are ordinarily found in the skin may cause the infection. The arrangement of the lymph channels and milk ducts, and the connective tissue structure of the breast, radiating in every direction from the nipple as a center, account for an infection following one or more of these structures and becoming localized at any distance from the nipple. It may then progress to the formation of abscesses varying in size and location.

Upon examination one or more points of induration are commonly found.

The tissues over these points are edematous and there is pain upon pressure. If the infection is advanced there is also redness or fluctuation present. The acuteness of the attack will differentiate this condition from tumors.

Aside from the history of lactation there may also be one of traumatism, or there may be evidences of an infection in some other portion of the body.

Rest and methods of prevention. Early in the occurrence of an infection of the breast it is frequently possible to cause it to subside by securing absolute rest. The blood supply of this portion of the body is so plentiful that an extensive amount of infectious material may be entirely absorbed if the progress of the infection is not favored by motion. The patient should therefore be placed in bed and the breast supported by strapping, preferably with rubber adhesive straps that have been carefully applied, or with an accurately applied flannel or elastic rubber bandage. If the infection is quite slight then a large, moist, antiseptic dressing covered with rubber protective tissue will probably best favor absorption, the patient of course being kept at rest. Further infection should be prevented by thoroughly washing the nipples before and after each nursing and by applying some antiseptic substance, such as ointment containing boric acid or some substance like tincture of benzoin or tincture of myrrh, which has a protective effect on account of its resinous character. Solutions of rubber have been prepared which may be applied to the nipple after it has been carefully dried, and which will serve as an excellent protective covering. Above all things the nipples should be kept clean at all times and should be carefully washed just before and just after nursing. The child's mouth should also be washed in order to prevent infection from this source. The milk should be pumped out of such a breast at regular intervals, care being taken not to cause any traumatism of the infected tissues by the manipulations which are thus necessitated.

Technique. If the infection progresses to the formation of circumscribed abscesses these should be incised freely and drained by the insertion of gauze or gutta percha tissue drains and a sufficiently large dressing should be applied to absorb all of the discharge. Personally, we prefer a moist antiseptic dressing consisting of one part of alcohol with two parts of saturated solution of boric acid for this purpose.

It is important that the incisions should be made in a manner so as to cause them to radiate from the nipple in order to prevent cutting off any of the ducts which branch from this point. Rest in bed and support by means of dressings and bandages should be insisted upon, because this will prevent any formation of further abscesses by progressive infection after the primary focus has once been opened.

CHRONIC MASTITIS

Chronic mastitis is the result of a deep-seated infection with pus microbes of moderate virulence. This condition may give rise to the diagnosis of tumor of the breast.

The application of a large glass bell attached to an air-pump, according to Bier's method, once each day over a breast which has been incised for the relief of abscess greatly facilitates the patient's recovery. The negative pressure must, of course, be carefully regulated to prevent unnecessary pain.

In protracted cases that come under the care of a surgeon a long time after the abscess has been lanced, so that only a sinus is left, we have had satisfactory results by applying Bier's vacuum pump and later injecting the sinus with Beck's bismuth paste.

TUMORS OF THE BREAST

Dangers of even simple growths. The most common benign tumor in the breast is the fibro-adenoma. Pure fibromata and pure adenomata are exceedingly rare. Aside from these are found retention cysts, lipomata, enchrondromata, and, very rarely, hydatid cysts. All of these tumors are likely to occur in young patients. They are movable and are not accompanied with retraction of the nipple. They give rise to no pain and rarely grow to any considerable size. We have, however, observed a large number of cases in which such tumors remained perfectly harmless until the patient's age exceeded forty years, when the condition changed, at first usually so slowly that the patient hardly was aware of the alterations, then definite, stinging pains were felt and later a slight degree of induration. The history would then show that when the patient came under observation it was plain from the external examination that we had to do at best with an adeno-carcinoma, although in these

CHRONIC CYSTIC MASTITIS OF THE RIGHT BREAST. MAMMECTOMY 7 YEARS PREVIOUS FOR A SIMILAR CONDITION ON THE LEFT SIDE. TREATMENT—TOTAL EXCISION OF THE RIGHT BREAST.

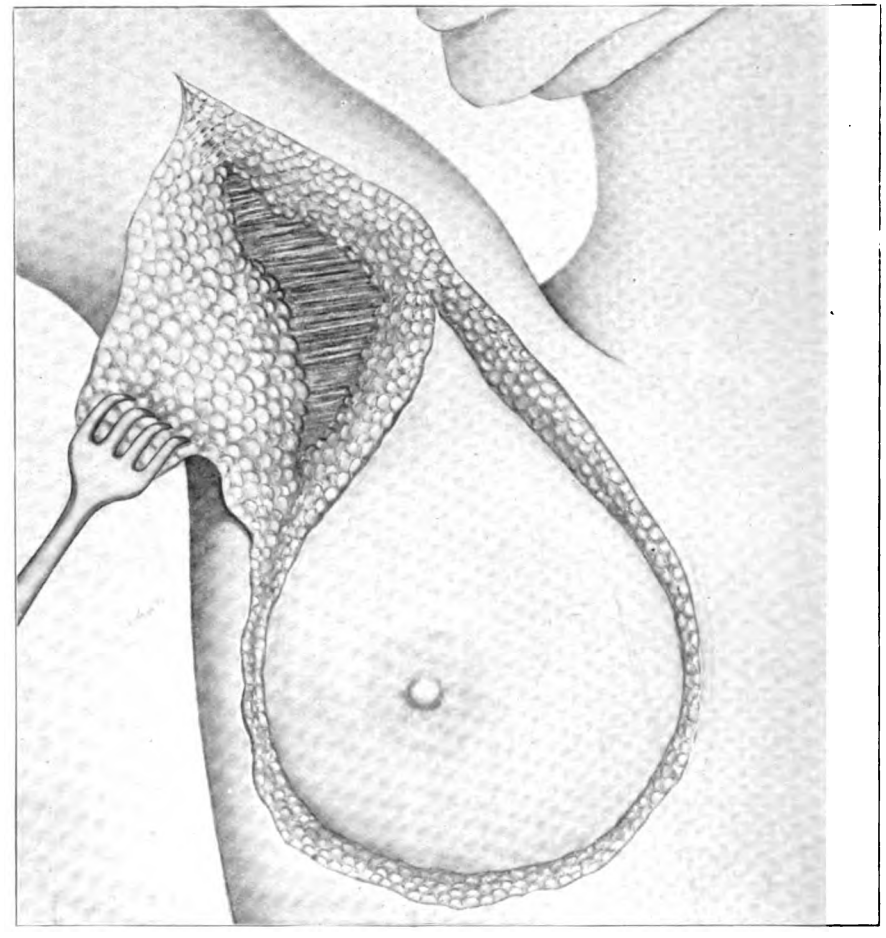
cases of long standing there could be no doubt but that they had started as perfectly benign growths. We have encountered many of these which were hopelessly-advanced, inoperable carcinomata when they came.

Accepting the general statement that there is a tendency in all tumors of the breast, with the exception of lipomata, to become malignant later in life, it consequently seems wise to remove every benign tumor in this location as early as possible after it has been discovered. The operation is safe, does not inconvenience the patient, and may relieve her of a very serious danger.

Carcinomata are the most common of all malignant tumors of the breast. Epitheliomata are less frequent; sarcomata still less frequent in their occurrence. Paget's nipple, which is a dermatitis with a tendency to the development of epithelioma, is not very common in this country.

Physical signs. Heredity is supposed to be an important element in the history of malignant tumors of the breast. The growth itself may have existed in the form of a benign tumor for a considerable period of time (as has just been pointed out), or it may appear in the form in which it persists. Its location is more commonly directly underneath the nipple, but it may occur in any

portion of the breast. At first it is movable, but later it becomes adherent to the skin or to the fascia of the pectoralis major muscle. One of the signs which has been recognized as characteristic is the *retraction of the nipple* due to the contraction of the underlying trabeculæ of the connective tissue. This condition, however, is present only if the tumor is near the nipple. If the growth is slow the tumor is hard; if it is rapid it may be either soft or hard upon pressure.



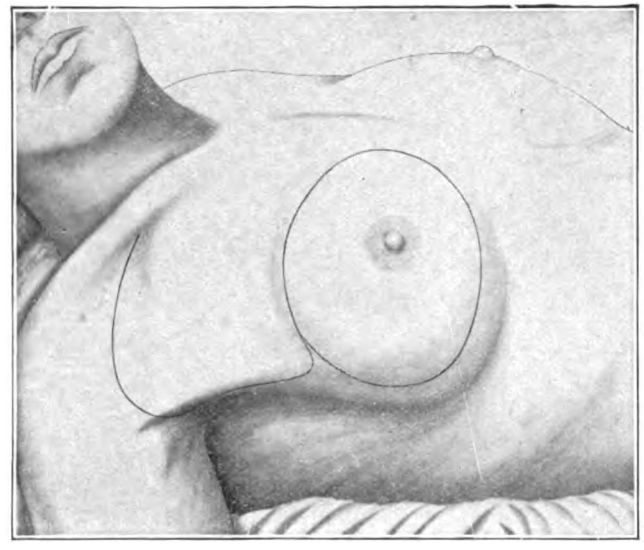
AMPUTATION OF BREAST.

The incision extends in front of the auxillary space and includes a considerable amount of skin overlying the mammary gland.

Sooner or later the disease progresses along the lymph channels, forming secondary nodules in the lymph glands, first in the axillary region, second, in the infra-clavicular and later in the supra-clavicular region. Still later, lymph channels extending toward the skin are invaded and the latter is presently destroyed, giving rise to an open ulcer.

A dangerous custom. At this point we wish to state emphatically that observations have convinced us that an enormous amount of harm is done to patients suffering from incipient carcinoma of the breast by the careless manip-

ulation of this organ by the physician or surgeon making the examination, or by any other persons handling the part. We believe that many times we have seen the growth of carcinoma of the breast largely increased in this manner. We believe also that we have observed cases in which secondary infection of the lymphatics, and even of the liver, was caused by frequent manipulation. During the past few years we have encountered a number of patients suffering from this disease who were treated by severe massage at the hands of osteopathic healers, in whom there was an enormous increase in the growth of the tumor in a relatively short time, and in several cases a secondary infection of the liver. In the same manner an infection with carcinoma may extend into the chest, following the lymphatics which accompany the internal mammary artery; or the opposite breast may be invaded because of the lymphatic connection between the two organs; or it may extend along the intercostal lymphatics into the spine, giving rise to paraplegia dolorosa.

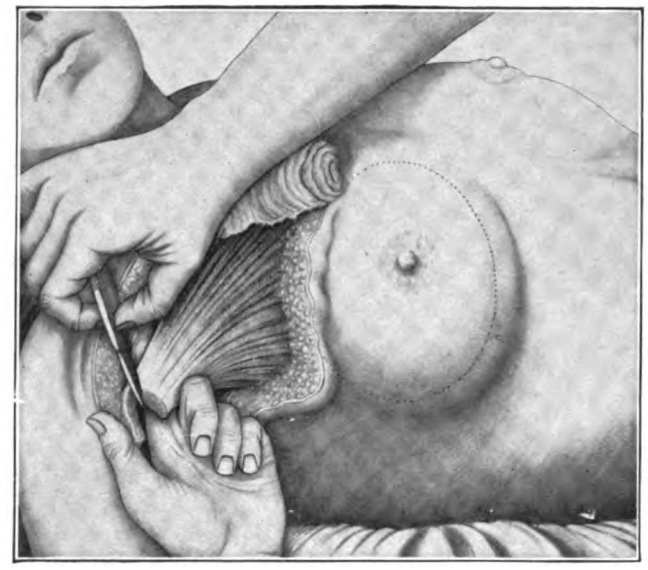


OUTLINE OF INCISION, MARKED WITH A SCRATCH STROKE OF THE KNIFE.
(Jabez Jackson.)

If there is any doubt as regards the diagnosis of carcinoma of the breast we believe that in every case it is much better for the patient to have the organ removed at once, and with the same care that would be exercised if its malignancy were positively known, rather than to temporize until the condition becomes so plain that the surgical treatment is usually useless and the patient therefore in a hopeless state.

Age incidence. Carcinoma containing an abundance of connective tissue is more likely to occur in those advanced in years, and the malignancy of this form is not so great as that in carcinoma with but a slight amount of connective tissue. The latter form of carcinoma is more likely to occur in young persons, usually under forty years of age. Sarcoma is also more prone to occur at this age, while epithelioma, starting in the skin and penetrating the deeper tissues, is more apt to develop in patients over forty years of age: *but it is not safe to depend upon the age in making a differential diagnosis between benign and malignant tumors of the breast.*

To differentiate between chronic mastitis and tumors, it will be found that when the breast is pressed against the chest wall with the hand in mastitis the enlargement is of uniform consistency, in tumors there is a nodular arrangement of the thickening.



EXPOSURE AND DIVISION OF THE PECTORALIS MAJOR.
(Jabez Jackson.)

Operative principles. There are a few important principles which should be remembered in the removal of a carcinoma of the breast:

1st. The direction in which carcinomatous infection progresses from the primary seat of disease, and consequently the direction in which recurrence is likely to take place, should be noted. Bearing this in mind, it is important to remove a large portion of skin overlying the tumor, even though the tumor itself be quite small.

2nd. The subcutaneous fat should be removed for a great distance.

3rd. All the tissues to be removed should be included in a continuous mass to prevent the infection of any portion, during the progress of the operation, from an exposed part of the malignant growth.

4th. All the soft tissues down to the ribs, to a point up under the clavicle, as far as possible into the axilla, including the overlying skin, the superficial and deep fascia, the fat, the entire breast enclosed in its capsule, the pectoralis major and minor muscles, and all the axillary and subclavian fat, together with the lymphatic glands contained in it, should be removed in one mass.

5th. The patient must be protected against too great a loss of blood.

6th. The important subclavian and axillary vessels and the pleura must not be injured.

Lines of incision and technique. Many incisions have been planned and for each certain advantages are claimed. It is probably of little importance which is chosen. A very good exposure may be obtained by making a curved wound, beginning at a point four inches below the axilla along the anterior surface of the deltoid muscle, extending across the chest at a sufficient distance from the tumor to insure safety against infection, usually six to ten centimeters

from the nipple will suffice, then carrying this incision around the breast at a uniform distance from the nipple and extending upwards to the original point, as shown in plate. The most satisfactory incision for the removal of extensive carcinomata in our experience is the one introduced by Rodman, as shown in plate, because it secures at once the complete removal of all the infected skin, secures a free approach to the diseased tissue, and provides for the perfect closure of the wound.

After grasping the bleeding vessels with pressure forceps the skin around the edges of this incision should be dissected up, the underlying fat being left attached to the chest wall. This dissection should be carried a sufficient distance back to include all the diseased tissue, at least five centimeters in each direction in ordinary cases. The incision is then carried down to the ribs along the border of this area and the entire mass, as described before, is

ISOLATION AND DIVISION OF THE PECTORALIS MAJOR.
(Jabez Jackson.)

dissected up to a point approaching the axillary vein, care being always taken to grasp the bleeding vessels with pressure forceps. Then the attachment of the pectoralis major to the humerus is severed and, later, the lower attachment of the pectoralis minor is also divided. Between these two attachments it is wise to grasp the vessels with two pairs of forceps, to cut between these and to ligate the stump toward the axillary side. The distal ends of the sub-clavian and axillary veins are now dissected free, all the small branches issuing from the veins being caught in two pairs of hemostatic forceps. Cut between, and ligate the end toward the axillary vein at once for fear of tearing the latter with the forceps. By proceeding slowly with this portion of the work it is possible in a comparatively short time to lay bare the entire vein without doing any harm to this structure. The dissection is then carried downward through the axillary space, and the entire mass cut away from its posterior attachment, the bleeding points having been caught carefully during each step of the operation so that the entire amount of blood lost will be slight.

It is important that the tumor be not manipulated roughly because it seems

likely that carcinomatous cells could be loosened from the substance of the growth if careless handling or pressure be allowed.

If there still remain small portions of fat attached to the axillary structures they can be removed with great rapidity and perfect safety by grasping them in a piece of moist gauze held in the hand and drawing this gauze over these structures, permitting them to slip through the grasp of the hand holding the gauze. In this manner these small portions of fat containing minute lymphatic glands may be removed more perfectly and with much greater ease and rapidity than by actual dissection. All the bleeding vessels that have been caught, from which bleeding has not been stopped permanently by the pressure of the

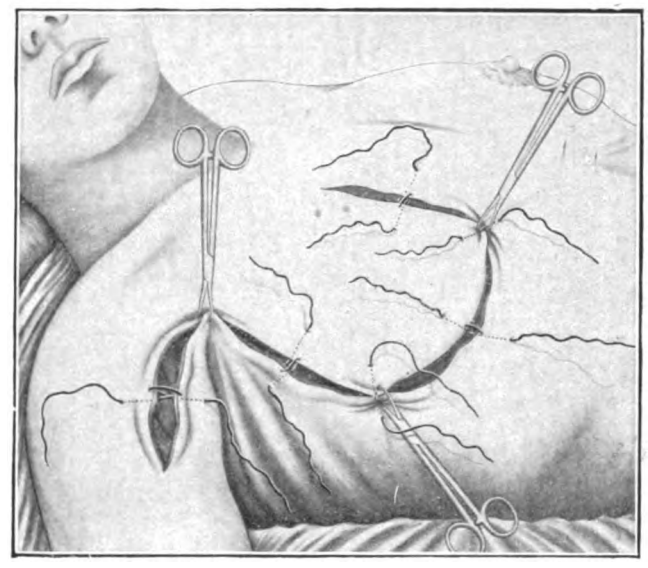
PECTORALIS MUSCLE SEVERED FROM BENEATH, AND PERFORATING BRANCH OF THE INTERNAL MAMMARY CAUGHT WITH FORCEPS.
(Jabez Jackson.)

hemostatic forceps, should be ligated. We make use of fine catgut for this purpose.

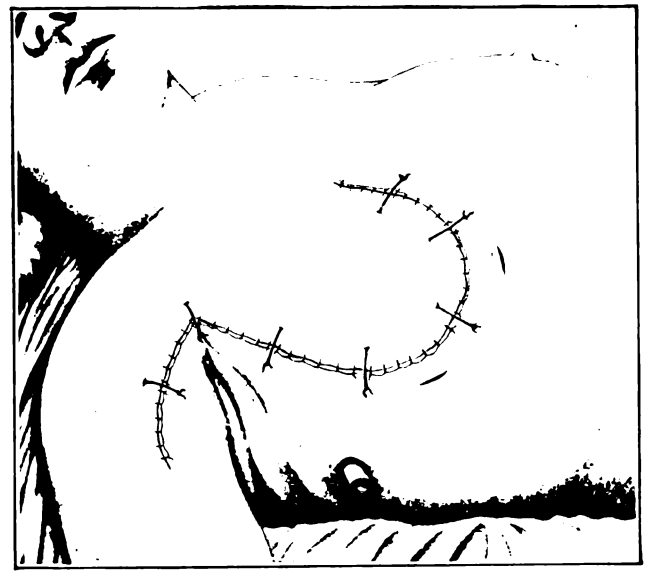
For a number of years we have followed the plan of preserving the distal end of the pectoralis minor muscle and cutting away only the proximal half of it for the purpose of covering the axillary structures. After thoroughly removing all the fat and lymph nodes in the axilla, the cut end of the distal portion of the pectoralis minor muscle is sutured to the intercostal muscles so that this remnant of the pectoralis minor muscle protects these structures.

The area exposed is so enormous that a certain amount of serous discharge must be expected, and consequently we believe it is wise to insert one or two moderate-sized drainage tubes through an opening in the posterior flap, as shown in plate. The wound is then united by means of interrupted tension sutures, for which silk or silk-worm gut may be employed, and coaptation

sutures for the purpose of adjusting the edges of the wounds. If these edges cannot be adjusted without applying a great amount of tension it is much



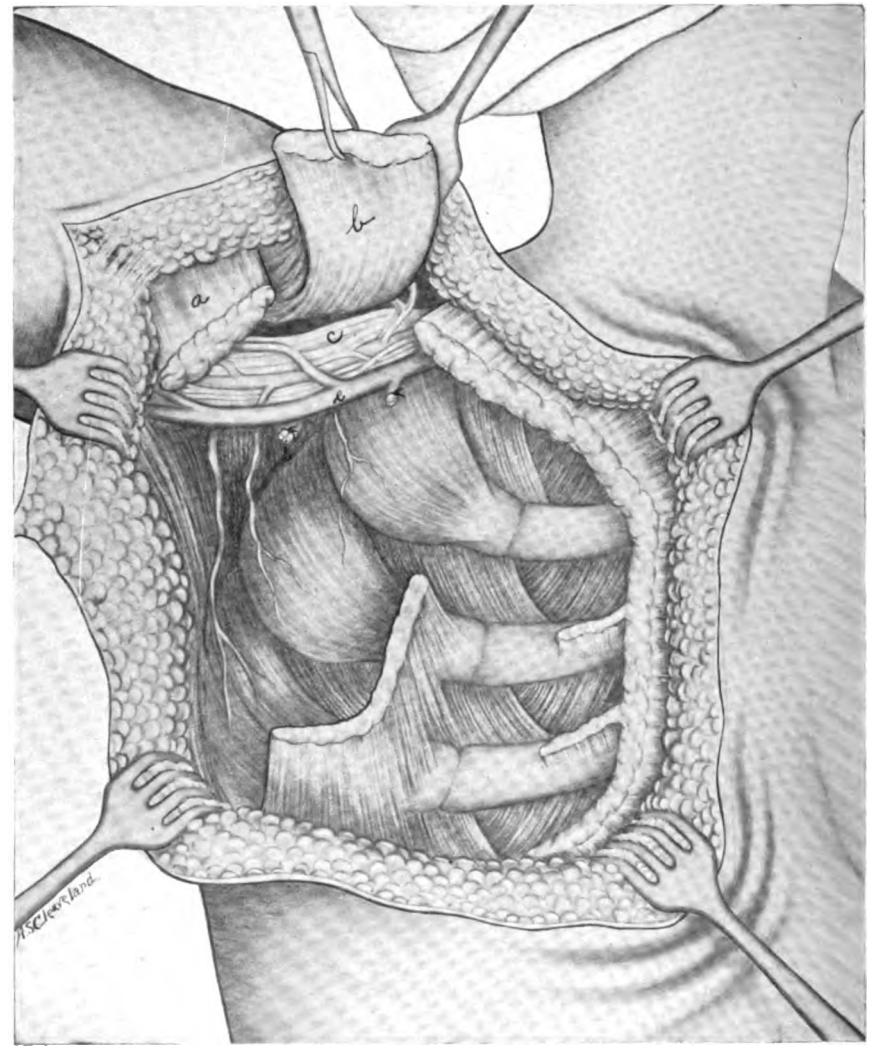
METHOD OF INSERTION OF FIGURE-OF-EIGHT COAPTATION SUTURES.
(Jabez Jackson.)



FLAP SUTURED IN PLACE WITH DRAINAGE TUBE INSERTED.
(Jabez Jackson.)

better to leave a space between the edges of the wound and to cover this by means of Thiersch's skin-grafts.

A large dressing is applied to the breast in order to approximate the skin flaps to the chest wall by means of gentle pressure. The arm, to the elbow, is included in the bandage, but should not be tied down sufficiently firm to make the patient uncomfortable.



AMPUTATION OF BREAST FOR CARCINOMA.

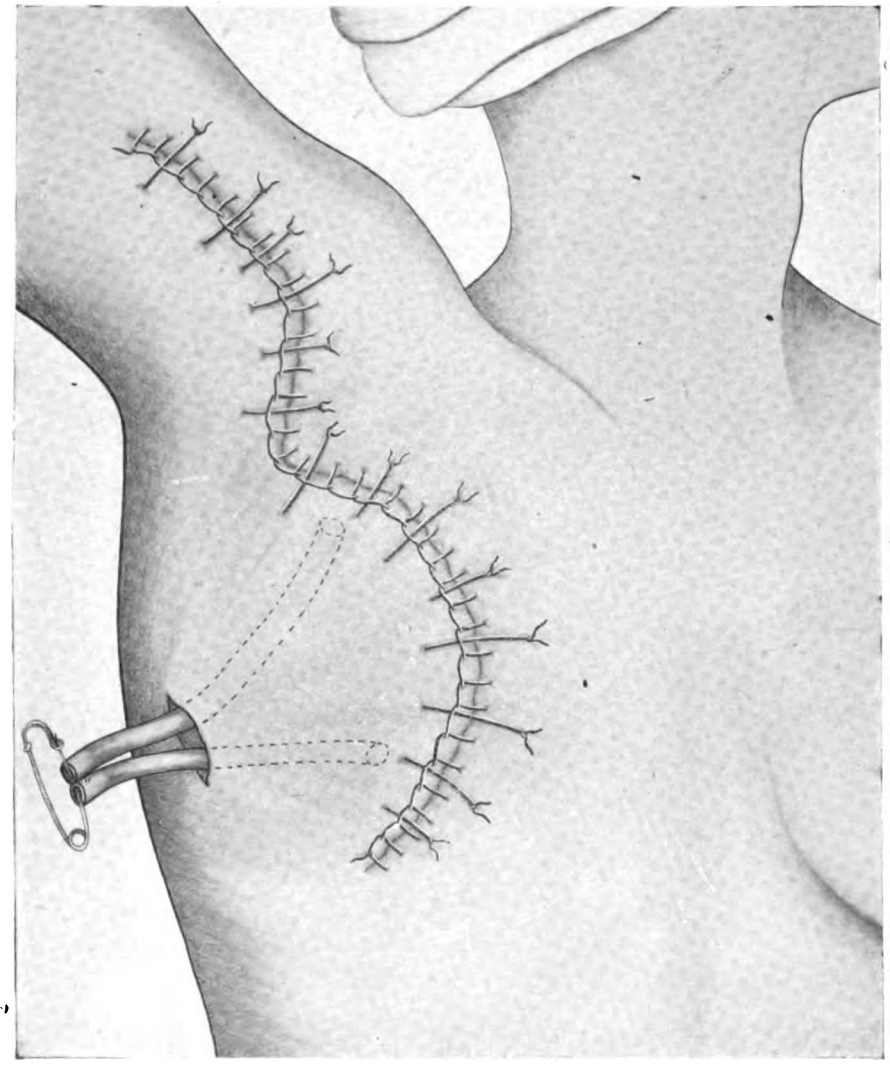
a cut end of pectoralis major muscle; *b* cut end of pectoralis minor muscle; *c* brachial plexus of nerves; *e* axillary vein.

Rodman's method. The incision described above, which was first introduced by Jackson, is so satisfactory that it may not seem necessary to describe other methods, but the authors have used the method of Rodman during the past five years in a large number of cases and have found it even more satisfactory, consequently it may be interesting to add a short description thereof.

An incision is made through the skin from a point near the middle of the

clavicle directly backward, being careful to remain far enough away from the breast to be beyond every portion of the growth.

From this incision a second one is carried above and a third one below the breast and directed toward the sternum, where they meet, then an incision is



AMPUTATION OF BREAST FOR CARCINOMA.

The wound has been sutured and drainage tubes are in place.

carried downward from this point directly over the upper end of the rectus abdominis muscle, whose anterior fascia is removed because it may contain infected lymph nodes. The flaps are reflected as described above. The axilla is exposed by dissecting up the flap formed by the first incision.

Then the breast, together with the pectoralis major and minor muscles and all the axillary fat and lymph nodes, is removed in the manner already described.

The advantage of this operation lies in the fact that after healing there is no scar in the skin of the axilla, and in the removal of the fascia of the upper end of the rectus abdominis muscle.

DISSEMINATED LENTICULATE CARCINOMA OF THE SKIN OF THE BREAST. (CANCER EN CUIRASSE.)

This form occurs not infrequently as a direct cancerous infection of the lymphatics of the skin after an operation for the removal of primary carcinoma of the breast. The infection may also occur directly from the primary carcinoma.

CANCER EN CUIRASSE.

The French name, indicating the appearance of a coat of mail, is so characteristic that one can scarcely fail in making the diagnosis. Near the region of this complication the skin is thickly studded with nodules, usually red in color, and radiating from this area to a considerable distance will be found smaller lenticular nodules. A few times we have observed this form of secondary carcinoma originating in the stitch mark, indicating that the carcinomatous tissue was directly inoculated in the skin from the deeper portions. It is likely that the subcutaneous fat contained the carcinoma cells in these instances and that these cells were carried by the needle into the overlying lymphatics of the skin proper.

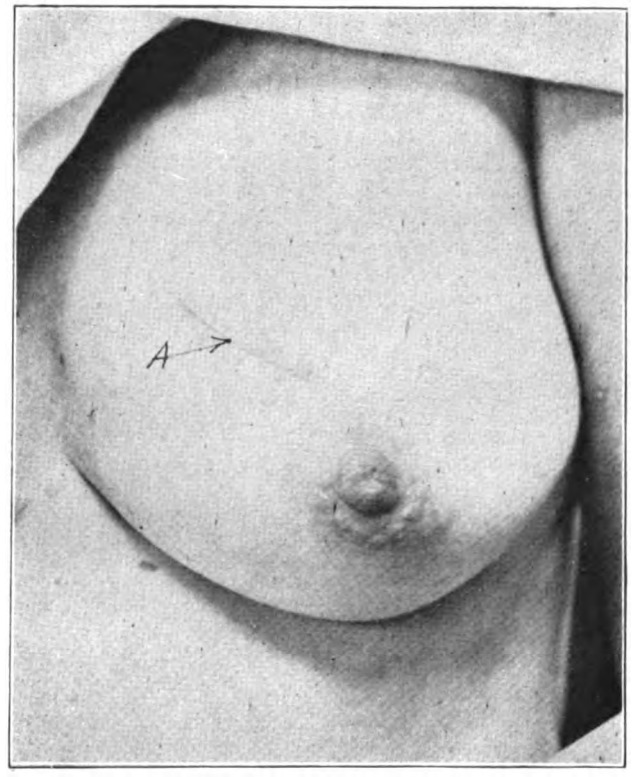
The surgical treatment must be entirely prophylactic. By removing a large

portion of the overlying skin, together with the carcinoma of the breast, it is likely that this complication will be prevented.

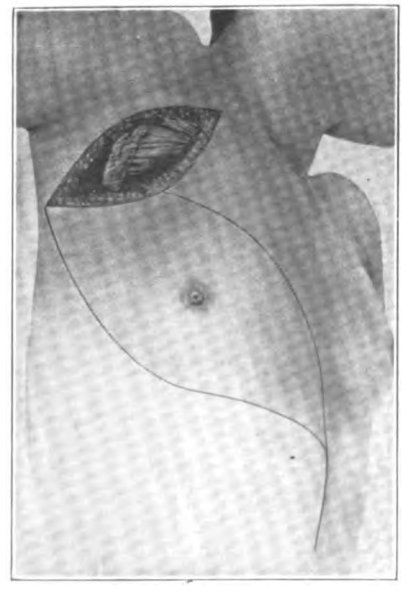
During the past few years a number of these apparently hopeless cases have recovered after the use of the Roentgen rays. Whether such recovery is to be permanent or temporary remains to be seen. In our own experience no patient has ever presented herself for treatment of this condition to whom we could promise any surgical relief. Whether the excision of a large portion of skin and underlying fat would give relief in cases coming under treatment very early we are unable to state.

SCAR FOLLOWING COMPLETE MAMMECTOMY FOR CARCINOMA OF THE BREAST.

Recurrence. In order to prevent a recurrence it is important to bear in mind everything that has been said above concerning the technic, but especially that in patients suffering from very small tumors the operation must be made quite as extensively as in the presence of a larger growth, because only in this manner is it possible to prevent them from suffering from hopeless recurrences, for in these cases it frequently happens that a few carcinoma cells find their way into the lymph canals and are caught by lymph nodes at a considerable distance, and if these latter are not removed during the primary operation a recurrence is of course inevitable. The recent anatomical studies upon fresh cadavers by Moreau has given us still further reasons for being very careful in following the lymph nodes. He has demonstrated that the axillary fascia is a continuation of the middle cervical fascia, begin-

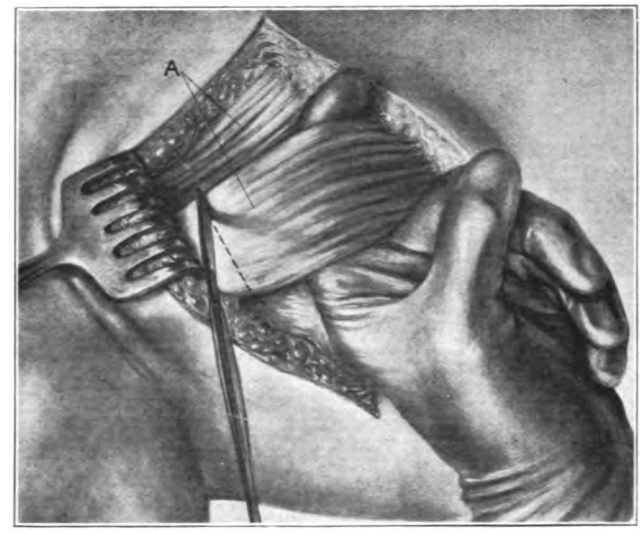


RECURRENT CARCINOMA OF THE BREAST FOLLOWING EXCISION OF A PART OF THE TUMOR. AXILLARY METASTASES PRESENT. TREATMENT—COMPLETE MAMMECTOMY. AT "A" IS SEEN INCISION OF INCOMPLETE OPERATION.

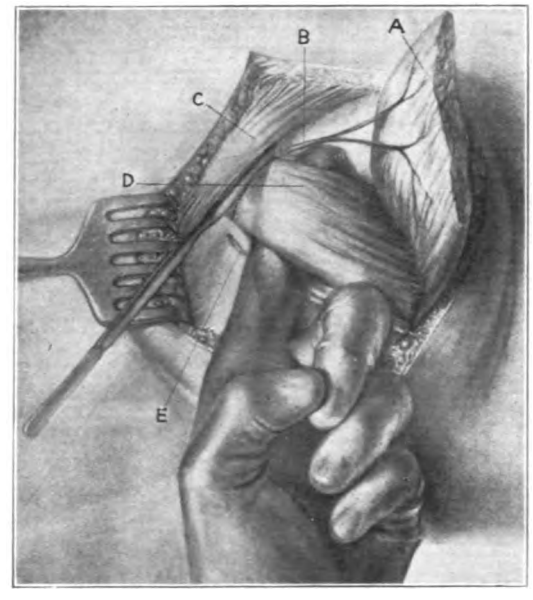


RODMAN'S AMPUTATION OF THE BREAST FOR CARCINOMA.
(We are indebted to Dr. D. Guthrie of Sayre, Pa., for these six drawings.)
Represents the typical incision.

ning at the posterior surface of the clavicle and passing downward behind the subclavian muscle down to the pectoralis minor muscle, then passing



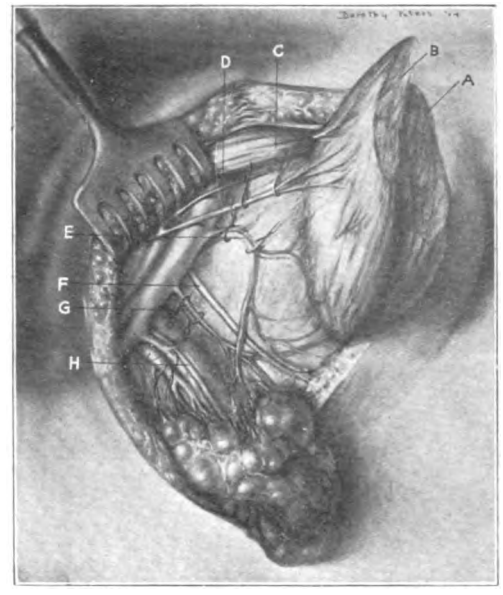
The section of the pectoralis major muscle.



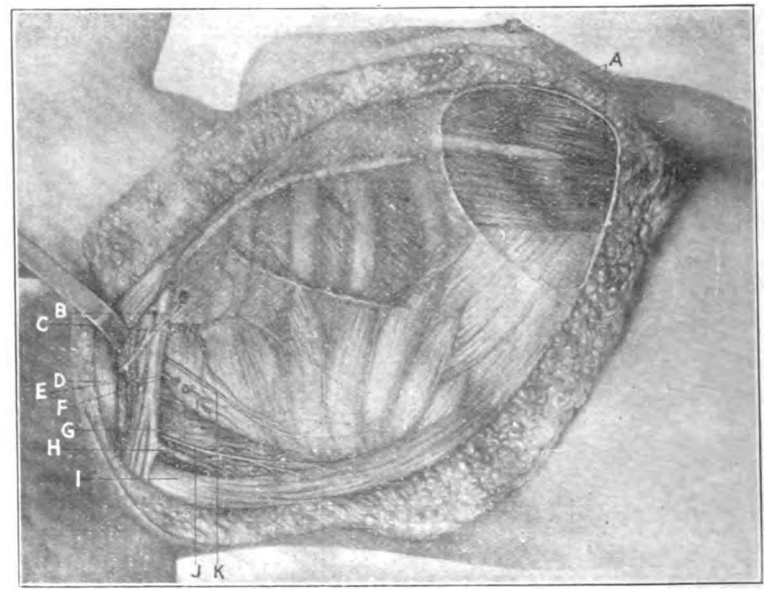
Shows the pectoralis major muscle turned up and the finger inserted underneath the pectoralis minor muscle represented by the letter D. A, represents the pectoralis major muscle; B, the acromiothoracic artery; C, clavicular portion of pectoralis major; D, pectoralis minor; E, the long thoracic artery. [See following page.]

behind this into the axilla, where it forms the base of the axilla. Then it turns slightly upwards in front of the latissimus dorsi and teres major muscles and becomes attached to the lateral edge of the scapula.

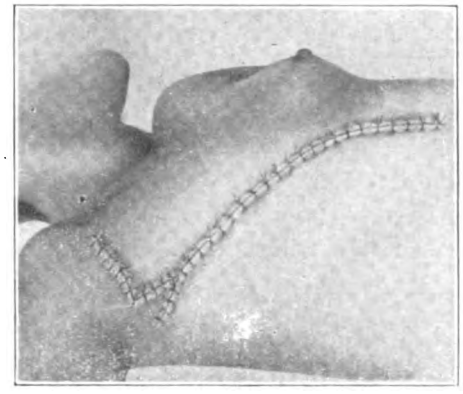
It is plain that this arrangement leaves the space quite free for progressive carcinomatous infection after the axilla has once been involved.



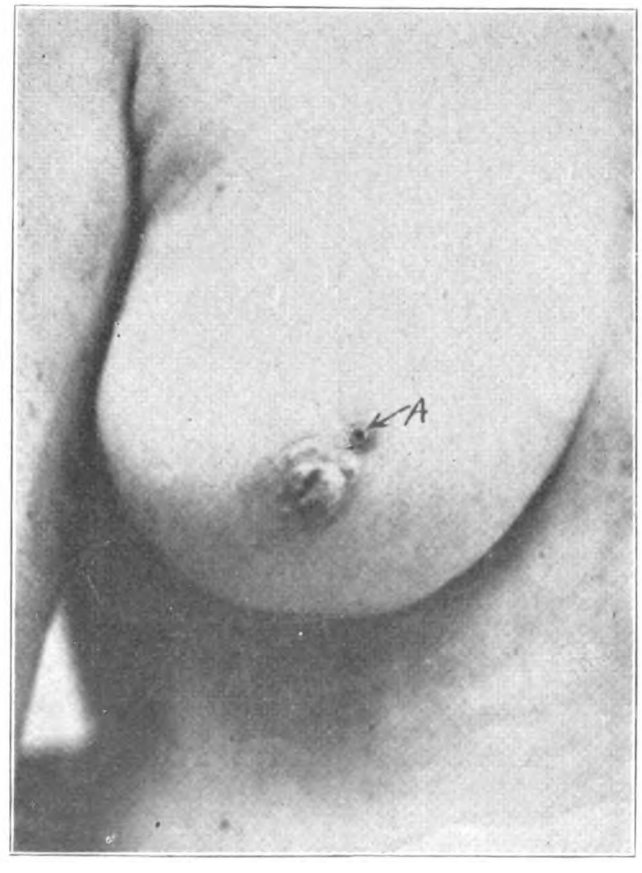
Shows the axillary structures perfectly exposed. A, pectoralis major muscle; B, pectoralis minor; C, clavicular portion of pectoralis major; E, long thoracic artery and vein; F, nerve of Bell; G, alar thoracic artery and vein; H, subscapular artery, vein and nerve.



Shows the entire excision completed. A, sheath of rectus muscle; B, acromiothoracic artery; C, long thoracic artery; D, clavicular portion of pectoralis major not removed; E, axillary vein; F, alar thoracic artery; G, subscapular muscle; H, subscapular artery and vein; I, latissimus dorsi muscle; J, subscapular nerve; K, nerve of Bell.



Shows the manner in which the wound is closed without any scar tissue in the axilla.

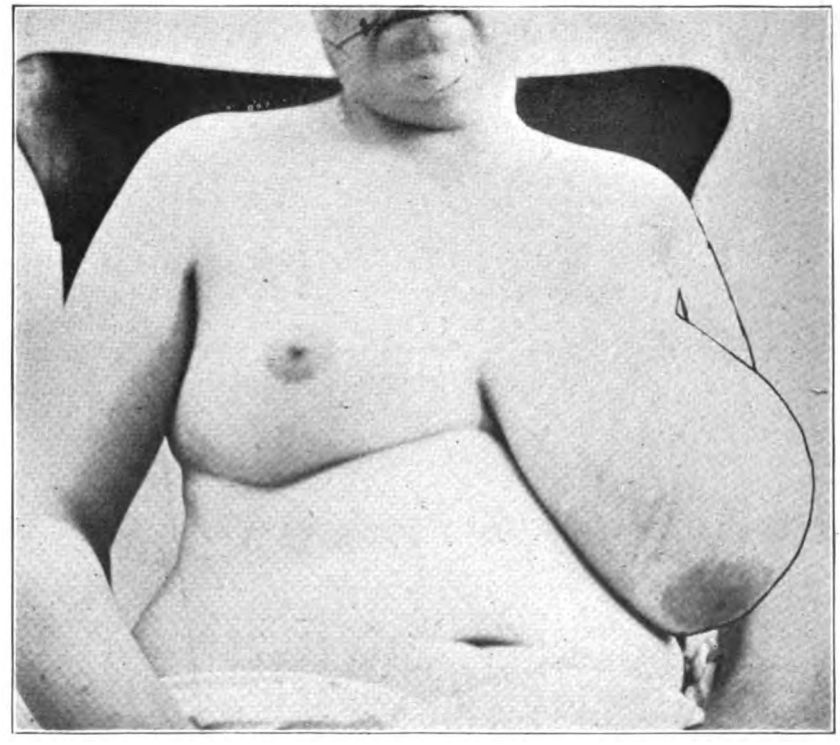


BASAL-CELLED EPITHELIOMA OF THE BREAST. AGE OF PATIENT, 52 YEARS. TREATMENT—COMPLETE MAMMECTOMY.

EPITHELIOMA OF THE BREAST

Primary epithelioma of the nipple is not very uncommon. Its progress is likely to occur more rapidly into the deep structures than into the surrounding skin. Even at a very early stage there has usually been a secondary infection of the tissues of the breast itself. In a few instances in which the disease seemed to be very limited we have found that there was an infection not only of the tissues of the breast, but also of the axillary lymphatic glands.

The conditions just described will of course indicate that the same plan of treatment must be followed which has been outlined in connection with



LIPOMA OF THE BREAST.

carcinoma of the breast proper. If anything less is done the progress of the disease will only be increased and the patient is likely to succumb sooner than she would if nothing at all were done in a surgical way; in fact, with a thorough removal of the skin, the breast, the pectoralis major and minor muscles and the axillary and subclavian lymphatics and fat, these patients have a chance to recover permanently.

SARCOMA OF THE BREAST

The diagnosis of sarcoma of the breast can not usually be made positively until the tumor has been removed. This is of little importance, inasmuch as the same operation must be performed which would be done in the presence of a carcinoma.

TUBERCULOSIS OF THE BREAST

Patients suffering from tuberculosis of the breast usually give a history of tuberculosis in some other portion of the body, most commonly pulmonary.

In many cases there is the history of an injury; in others the history of localized tuberculosis of the lymph glands in other portions of the body. The history, together with the general appearance of the patient and the fact that the axillary glands are usually enlarged, while the examination of the breast itself gives the impression one obtains in manipulating a chronic mastitis or a multiple fibro-adenoma, usually suffices to make a fairly positive diagnosis of tuberculosis. There are, however, cases in which it is not possible to differentiate this condition from carcinoma. If the disease has existed for a more or less extended period of time some portion of the growth will have usually undergone caseous degeneration, giving rise to the sensation of fluctuation, which will also serve as a diagnostic sign. The nipple is usually retracted.

The treatment should consist in the removal of the entire breast, together with the lymphatic glands and fat of the axilla. It is not necessary here to disturb the pectoralis major or minor, or the fascia covering the former. Unless there is present a mixed infection of some broken down portion of the tumor it is usually safe to close the entire wound without drainage.

MILK FISTULA

Following an incision into the breast for the drainage of an abscess, or following the spontaneous opening of an abscess of the breast, and occasionally following traumatism, a fistula remains connected with one of the milk ducts which secretes milk either constantly or intermittently.

In recent cases these fistulæ can sometimes be cured by cauterizing the external opening, or by curetting the fistula, or by making a longitudinal incision through the fistula, but in chronic cases a careful excision of the false passage is necessary in order to secure permanent relief.

MOBILIZING THE CHEST WALL FOR RELIEF OF PERICARDIAL ADHESIONS

Pericardial adhesions to chest wall cause a condition which is at once most distressing to the patient and exhausting to the heart itself, as with each contraction the heart makes an unsuccessful effort to pull itself away from its fibrous attachment to the chest wall, and with each expansion it is pushed by the adhesion against this rigid wall.

Mobilizing this rigid wall then over the area occupied by the heart must necessarily bring great comfort to the patient, and must at the same time reduce greatly the wear and tear upon the heart itself. This may be accomplished by the following operation:

Technique. A curved incision is made just below the left mammary gland from fifteen to twenty cm. long; the breast is reflected upward and the fourth, fifth and sixth ribs are laid bare. The middle of the area to which the pericardium is adherent is determined by the impact of the heart and each rib is excised to the length of twelve cm. so that a vertical line drawn through the center of the area of impact would bisect each fragment of rib removed.

In making this excision if possible all of the periosteum should be removed with the ribs, so as to prevent their regeneration.

The skin and muscle flap is then replaced, two small gutta percha tissue or fine rubber tube drains are inserted, and the wound is closed.

The relief is almost instantaneous, because the soft wall which takes

the place of the rigid costal wall yields readily with the motion of the heart, whose pulsation consequently becomes slower, with an improved character and quality of the contraction, and a rapid building up of the patient's general condition.

PERICARDIAL EFFUSION

While this can hardly be classed as a surgical disease, yet the surgeon is often called upon for relief when it has become distressing, and so it may be proper to contribute a few words to the subject at this point.

The heart is usually sufficiently far away from the chest wall, because of the presence of a large amount of pericardial fluid, to prevent injury when the trocar is inserted for the purpose of partial withdrawal of fluid.

The puncture should be made in the fifth or sixth intercostal space in the left mammillary line in large accumulations, which are the only ones that require this operation.

It is best to use a trocar two mm. thick with a very sharp but short pointed stillette. The distance to which this is to be plunged into the chest must be determined by holding the point of the index finger against the trocar so that it cannot be forced in any farther than contemplated. The stillette is then withdrawn and enough fluid is permitted to escape to give immediate relief, but not enough to shock the patient or to permit the heart to touch the pericardium.

The fluid should be withdrawn very slowly, with repeated interruptions, especially if there is any irregularity in breathing or in the heart's action during the progress of the operation.

The canula should be held in such a direction that there is no danger of the surface of the heart striking against it and becoming lacerated. The withdrawal of a portion of the fluid, usually from one to four ounces, is likely to stimulate absorption of the remaining portion, but if this does not occur the operation must be repeated whenever a sufficient amount has reaccumulated to give rise to much distress.

In introducing the trocar the intercostal vessels should be avoided by remaining near the upper margin of the rib, below the puncture point, and avoiding the lower edge of the upper rib. The fourth, fifth or sixth intercostal space should be chosen, according to the position of the fluid.

PERICARDIAL SUPPURATION

The condition just described may be followed by suppuration in the pericardial space. In this event it seems reasonable to expect that the two per cent. formaline in glycerine treatment introduced by Murphy for the cure of empyema of the chest should give satisfactory results.

Simple aspiration without free drainage has given such absolutely unsatisfactory results that this should never be practised, and in case of diagnosis of pericardial effusion and demonstration of the presence of pericardial suppuration upon aspiration the radical operation should be done at once.

The operation for the relief of this condition consists in the removal of ten cm. of the fourth or fifth rib over the most prominent portion of the pus sac, placing gauze into this wound for twenty-four to forty-eight hours and then, making a crucial incision through the middle of the exposed area, the pus is permitted to drain through a pledget of gauze or one composed of folded rubber tissue.

We have not had an opportunity to use Beck's bismuth paste in these cases in the after-treatment, but it seems plainly indicated where healing does not take place promptly after drainage has been installed.

In cases in which the intercostal tissues are edematous at the time of the operation it is not necessary to postpone the incision if the patient's condition is such as to make an immediate evacuation of the pus desirable, because there is no danger in these cases from the occurrence of hydrothorax, owing to the fact that the existing inflammatory process has produced the necessary adhesions to prevent this.

WOUNDS OF THE HEART

It is important to be familiar with some method of exposing the heart in case one should encounter a patient suffering from a stab or gunshot wound thereof. We have never had an opportunity to operate in one of these cases and consequently cannot speak from personal experience with any method, but the subject is so important and any surgeon is so likely to be in a position in which he must act promptly, that we will give the method advocated by Kocher because it has the advantage of great simplicity and at the same time fills all of the demands met by any or all of the many more complicated methods. It secures an easy, rapid approach to the heart, gives an excellent exposure of the organ and guards against the formation of pneumothorax. In hospital practice this should further be guarded against by the use of one of the various devices that have already been described; but most of these patients are so seriously injured that the time necessary to adjust an apparatus would probably be sufficient to permit the patient to die from hemorrhage unless the Fell or the Melzer type happened to be available.

The entire chest should be quickly saturated with compound tincture of iodine, which should always be at hand. The surgeon should put on sterile rubber gloves without stopping to scrub his hands.

If no tincture of iodine is available the skin should be scrubbed rapidly with warm water and soap with a piece of gauze, then with alcohol, then ether.

An incision ten cm. long is made from the middle of the sternum over the sixth costal cartilage to the bony part of the sixth rib, cutting the attachment of the rectus abdominis muscle. The pectoralis major is loosened from its attachment to the upper border of the rib and the attachment of the intercostal muscles is loosened both above and below with the knife. The perichondrium on the posterior surface is loosened with a periosteal elevator. The sixth costal cartilage is now cut at the point of its attachment to the sternum and that to the seventh costal cartilage.

The internal mammary artery and vein are seen at a point one cm. to the left of the sternum; they are clamped, cut and ligated.

Underneath this point the sternal attachment of the transverse thoracic muscle is cut, and the muscle, together with the pleura, is pushed to the left, which exposes the dense fibrous pericardium.

If the heart is compressed by the accumulation of blood in the pericardium this sac is opened at once, otherwise the following steps are taken:

If the wound is in the upper portion of the heart the incision is carried upward to the fourth, third or second intercostal space. Here a lateral incision is made eight cm. long through the pectoralis major muscle to the upper margin of the costal cartilage and rib. The intercostal muscle is

loosened from its attachment to the upper margin of this cartilage and rib. The pleura, together with the transverse thoracic muscle, is now separated from the cartilages and ribs and retracted to the left and a sufficient amount of the ribs, together with the cartilages, is cut away to provide the necessary space for the completion of the operation, which exposes the heart from apex to base. In case of injury to the pleura the opening is at once caught with clamps and later ligated or sutured with catgut.

It is not always necessary to make so complete an exposure of the heart because the wound may present itself at a point where the heart is first observed. In this case it is of course only necessary to close the wound at once and the operation can be completed without making so extensive a wound. On the other hand even this extensive exposure may not be sufficient when the right ventricle has been injured, in which case it is best to cut off the sternum transversely with bone-cutting forceps and turn it out of the way to the right. But it is only rarely necessary to make so complete an exposure of the heart.

The heart is grasped with two fingers of the left hand and the first suture inserted one cm. beyond one end of the wound. The end of the suture is left long and held by means of hemostatic forceps to facilitate the completion of a continuous suture. Fine silk or fine, very reliable chromicized catgut should be used for suturing a heart wound.

The pericardium and the pleura are sutured with catgut at once without drainage. The flap is then replaced and sutured and two small drains inserted to prevent accumulation of serum from the large wound surface.

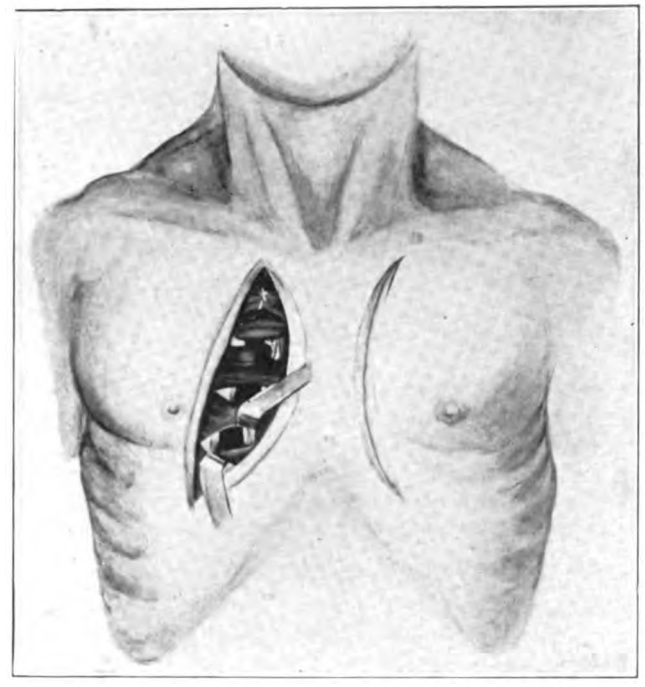
It is important to perform the entire operation with the very greatest precautions against infection, for this is practically certain to destroy the life of the patient in even the most hopeful cases if it occurs.

Transfusion of normal salt solution is indicated after the operation; and if possible transfusion of human blood by the method described elsewhere in this volume would undoubtedly be beneficial.

EXCISION OF COSTAL CARTILAGES FOR RELIEF OF EMPHYSEMA

This operation has been strongly recommended because it reduces the size of the chest and thus permits the emphysematous portions of the lung to contract. We have done this operation for this particular purpose only a few times and cannot therefore speak authoritatively concerning its beneficial effects, which, however, seem reasonable. The same operation we have performed frequently for the removal of diseased cartilages. It is simple and with reasonable care it is perfectly safe.

An incision is made along one border of the sternum, from five to seven cm. from its center, and extending from the clavicle to the lower border of the ribs. The soft tissues are reflected inward and outward and each cartilage is exposed successively. With a sharp, heavy cartilage knife the cartilages are cut off successively, then each cut end is elevated with a curved periostome and from one-half to three cm. of the cartilage is removed, the shorter excision being made at the upper ribs. The wound is then closed and dressed and a circular bandage of wide rubber adhesive strips, extending entirely around the chest, is applied the same as in the treatment of gunshot or stab wounds of the chest. The other side is treated in the same manner as soon as the patient's condition warrants a second operation, which should, however, not be performed too soon.



CHONDRECTOMY FOR RELIEF OF BRONCHIAL ASTHMA.

(From Dr. E. Wyllys Andrews, *Journal of A. M. A.*, Sept. 26, 1914.)

The figure shows the curved incision over the middle of the costal cartilages of the second, third, fourth and fifth ribs. The wound is retracted in order to expose the entire cartilage and the sternal end of each rib. At least 1 cm. of the rib with 2 cm. of its periosteum is removed, together with the entire cartilage of the four ribs, and also together with the perichondrium, in order that there may be no new bone or cartilage formed to fill in the space, but that this space will be filled in with flexible scar tissue instead. If cartilage and perichondrium are left the chest will soon again become rigid, and with this the patient will again suffer from his former difficulty in breathing. Great care must be taken in removing the periosteum and perichondrium posteriorly in order to prevent injury to the pleura.

FOREIGN BODIES LODGED IN THE BRONCHI

The most common foreign bodies encountered in the bronchi are small objects which children hold in their mouths while playing, like kernels of corn, peanuts, beans, tacks, pins, parts of playthings, etc.

If these are of metal or any other substance that will throw a shadow when the chest is exposed to the X-ray, so as to be seen through a fluoroscope, the object can sometimes be grasped with proper forceps and removed under guidance of the X-ray shadow.

Light objects like kernels of corn, beans, small buttons, etc., will usually be coughed out of the tracheotomy opening, if tracheotomy is performed with a dependent head, the patient being placed in the inverted position with the foot of the table elevated to about forty-five degrees.

Of course this will occur only if the object is not impacted, or has not been fastened by the occurrence of edema. If the object has become fixed its location may usually be determined by auscultation, as no air passes beyond the location of the foreign body. In these cases a low tracheotomy should be made and a forceps should be carried down the trachea into the bronchus

and down the bronchus until it touches the foreign substance, then the jaws of the instrument should be opened and the object grasped if possible.

At the present time it is, however, scarcely proper for any one without special training to undertake this operation. It is better to have the patient examined with the bronchoscope and the attempt at removal made by an expert.

So long as the object is in the trachea its removal, if this does not occur spontaneously upon opening the trachea, can be accomplished by any surgeon with ordinary skill and experience, while if it has passed beyond the bifurcation of the trachea then one side of the lungs is free and there is no danger of the patient losing his life from asphyxiation; at the same time the removal of the foreign body becomes thus very much more difficult, and hence there are two very good reasons why the patient should be taken to an expert.

At times parents are not certain as to whether a foreign body has actually been inspired. In these instances the patient frequently does not reach the care of a surgeon until the object has ulcerated through the wall of the bronchus and into the lung, giving rise to the formation of an abscess of the lung. In these cases skiagrams should be made both from an antero-posterior, and from a lateral view, in order to locate the object as nearly as possible.

The treatment indicated is that advised for abscess of the lung from any cause. These operations should be performed in the pneumatic cabinet, or with the help of the Fell bellows, because in this way the danger from pneumothorax can be avoided, the operation performed with much less hurry and the risk reduced to a minimum.

PART V

GENERAL SURGERY OF THE ABDOMEN

There are a few conditions connected with abdominal surgery which may be considered in a general way, as they apply to all cases in which the abdominal cavity is opened.

Preparatory treatment. In performing intra-abdominal operations the matter of space is of great importance, because an abundance of room facilitates the operation to a marked degree.

It is astonishing how much space may be gained by securing an empty condition of the stomach and intestines. If these are filled with food, gas and residue, the simplest operation may be quite difficult, while it will be many times less troublesome if the intestines are as empty as possible. Moreover, the proximity to the seat of operation of decomposing intestinal contents is not desirable. With only the thickness of the intestinal wall between the wound and this material the patient is not nearly so safe as he would be were the alimentary canal empty.

The stomach. Occasionally the stomach is found greatly distended with gas after the abdomen has been opened, and it may displace the other viscera, or it may interfere with the necessary manipulations during the operation or after the operation has been finished it may interfere with the closure of the abdominal wound, and later it may be the cause of much discomfort. It is consequently best to place the patient's head to one side in order to prevent inspiration of fluid from the stomach and to insert a stomach tube and perform gastric lavage either at once, as soon as the abdomen is opened if it interferes with work, or before the abdominal wound is closed. Usually some bile regurgitates into the stomach during the operation and this, together with the mucus the patient has swallowed, often causes post-operative nausea which is eliminated by the use of gastric lavage at the close of the operation.

In abdominal operations the infectious material from a foul condition of the patient's mouth seems especially undesirable and it is important to have teeth and tongue scrubbed thoroughly and repeatedly before these operations.

Cathartics. No other cathartic has accomplished emptying the intestines so thoroughly, in our experience, as castor oil, given in the foam of beer or malt extract on the day preceding the operation. We have found that two ounces is the most satisfactory dose. If given in this manner it rarely nauseates the patient, it causes very little or no pain, and it is certainly effective in almost every case, leaving the intestines free from gas and feces. It is well to give only sterilized food for twenty-four hours previous to the operation, preferably sterilized milk or broths.

Diuretics. After many intra-abdominal operations there seems to be an interference with the functional activity of the kidneys, rather more marked than in any other operations not performed directly upon the kidneys or urinary tracts. It is consequently wise to encourage their activity on the day before the operation by giving pure water, preferably hot, in considerable quantities.

The hot bath which has been mentioned in connection with the preparation of patients for operation in general is especially useful in these patients, because it stimulates the process of elimination through the skin as well as through the kidneys. In case there should be a lack of excretion of urine this can usually be induced by administering an enema of one-half pint of normal salt solution every hour until the condition is relieved. To these enemata from 10 to 25 grains of acetate of soda may be added until there is a free flow of urine. The same result may be accomplished in an admirable manner by the continuous proctoclysis introduced by Murphy and described elsewhere herein, normal salt solution being employed in this as in other cases. If this does not bring satisfactory results 1,000 cc. of normal salt solution may be injected subcutaneously before and after the operation.

Abdominal incisions. In making an incision through the abdominal wall, the anatomical layers composing this wall should be considered, for if they are not the closure of the cavity after the intra-abdominal operation has been completed may not be satisfactory and may result in a weakened point in the wall which may presently develop into a hernia, and this may be a many times more serious affliction to the patient than the condition for which the operation was originally undertaken.

The accompanying plate shows the arrangement of the layers of the abdominal muscles, together with the location and direction of the usual incisions through the abdominal wall in the median line and on the right. Of course, the same relative positions would be suitable on the left side, although on account of the location of the gall bladder and the vermiform appendix on the right side, many more abdominal sections are made through this than through the left wall.

The incision marked (a) is suitable for all operations upon the intra-abdominal organs located in the pelvis. In cases of chronic appendicitis the vermiform appendix can also be removed through this incision.

The incision marked (b) is suitable in cases in which the vermiform appendix and the right ovary and tube are implicated; (d) indicates the incision known as McBurney's, for the removal of the appendix; (c) is favorable for operations upon the gall bladder, and the appendix can usually also be removed through this incision; (e) offers the same advantages in the hypochondriac region that (d) gives in the iliac region; (f) furnishes an approach to the stomach; although we more frequently use incision (c) for this purpose, because, through this incision we can more conveniently inspect the gall bladder, duodenum and appendix.

In (a) and (f) the incision is made through the linea alba between the recti muscles; (b) and (c) split the fibers of the recti muscle, and (e) and (d) split the fibers of the external oblique, then the edges of this muscle are retracted and then the fibers of the internal oblique are separated, the incision extending at right angles to the fibers of the external oblique. The incision is then extended through the fibers of the transversalis fascia and the peritoneum.

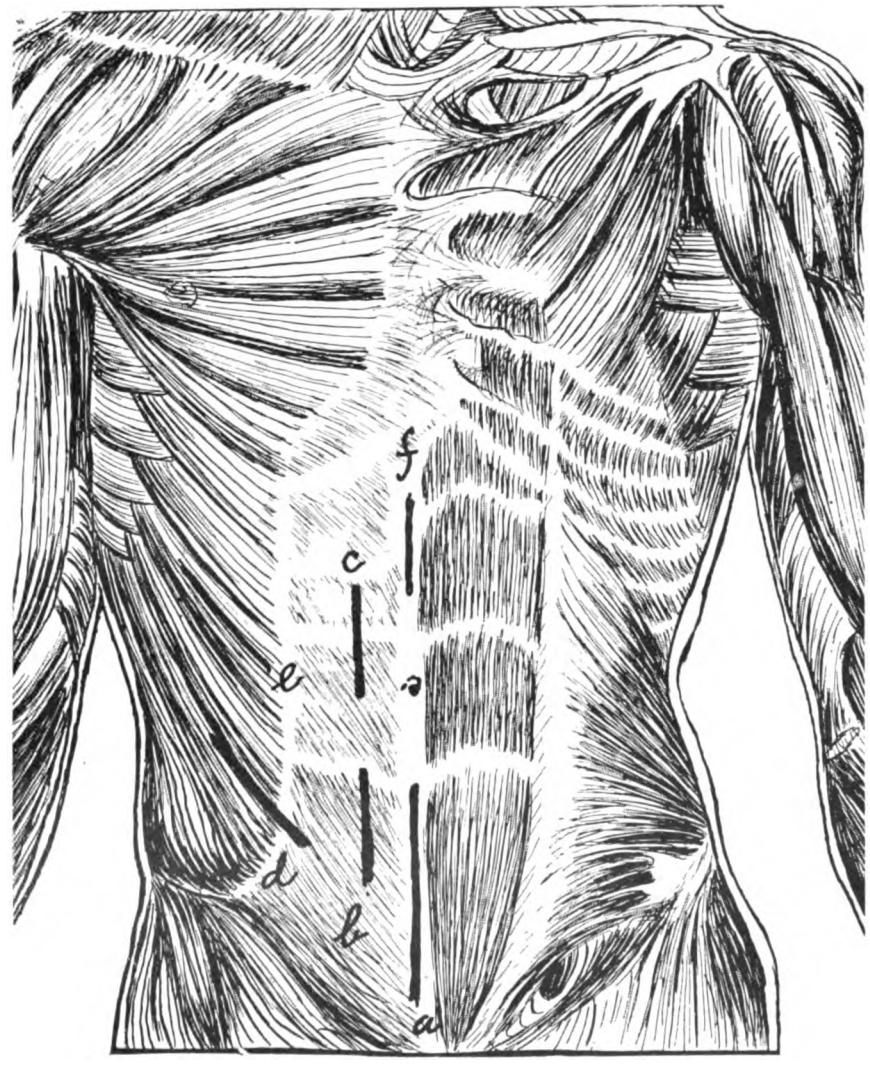
In all of these incisions none of the abdominal muscles are cut at right angles, which is of the greatest importance, for were they cut at right angles their ends would be retracted, and the more the muscles contract obviously the more the wound shows a tendency to gape. In closing a wound in the abdominal walls in which some of the muscles have been cut at right angles, it is often impossible to secure a satisfactory union between the cut ends of the muscle.

The conditions are entirely different if the muscle fibers have only been split according to the scheme indicated in the plate, as the natural contrac-

tion of these muscles has a tendency to bring their edges close together and to cause a spontaneous closure of the abdominal wound in this manner.

Each one of these incisions will be carefully described and illustrated in connection with cases in which it is to be employed.

These incisions may, of course, be changed as regards their distance from the median line, their length and their position upon the abdomen, so



LOCATION OF ABDOMINAL INCISIONS.

Represents the abdominal muscles with the various lines of incisions indicated on the right side; the same incisions may, of course, be practised on both sides of the abdomen, but the location of the vermiform appendix and the gall bladder makes these incisions more common on the right side. On the left side the external oblique abdominal muscle has been removed, showing the rectus abdominis and the internal oblique; (a) represents the incision through the linea alba below; (f) above the umbilicus; (b) through the outer edge of the right rectus abdominis muscle below; (c) above; (d) McBurney's incision; (e) the same incision over the kidney.

long as their direction corresponds with that of the muscles of the abdominal wall.

In order to make the position of these incisions more clear, they are shown in plate illustrating the surface of the body (see Part I), without indicating the direction of the underlying muscles, using the same letters as in the plate preceding for the various incisions. (See Part I.)

Traumatism. In no field of surgery is it more important to avoid unnecessary traumatism than in the abdomen. This can be accomplished by eliminating from the field of operation the portions not implicated in the disease by tamponing them away with large pads of soft, aseptic gauze, moistened with warm, normal salt solution. These pads should be applied carefully and gently, in order not to cause any traumatism, and left in place until the operation upon the diseased portion has been completed.

None of the intra-abdominal tissues not implicated in the disease should be manipulated during the operation, in order to avoid unnecessary shock and possible infection and consequent adhesions. Manipulation of inflamed or congested intra-abdominal organs is especially likely to give rise to shock, and in these cases it is consequently even more important to limit the manipulations as much as possible. So long as the peritoneal surface has not become abraded the likelihood of infection is very greatly reduced, and the less these organs and tissues are manipulated the less likely are they to suffer the abrasion of their peritoneal surfaces.

Gaseous distension. Much of the discomfort following abdominal sections results from gaseous distension of the intestines. This can be reduced to a very marked extent if the alimentary canal has been thoroughly emptied before the operation and if no food be given by mouth for a day or two after the operation.

The patient may be supported very well by the administration of one of the numerous predigested foods in the market given by enema. One ounce of this is given in three ounces of normal salt solution every three to four hours. Or if this is not convenient, a simple enema of eight to sixteen ounces of normal salt solution given every three to four hours seems to relieve the sense of hunger.

Both hunger and thirst after operation are relieved by the use of continuous normal salt solution proctoclysis. It is usually best to give this for two hours continuously, then to interrupt it for two hours or until the patient becomes thirsty, and then to repeat. This also is an excellent means for preventing shock.

The amount of pain suffered after an intra-abdominal operation is also greatly reduced if no food be given by mouth. In case, however, there should still be a considerable amount of pain, this may be relieved safely by the use of morphia hypodermically. This is not safe when food has been administered, because the relaxing influence of morphia upon the intestinal walls will have a tendency to increase the gaseous distension and the consequent absorption of products of decomposition. We wish to emphasize this point most vigorously, because nothing can be more harmful after abdominal operations than the use of opium or morphia in any manner if some form of nourishment is given by mouth at the same time; while in cases in which the canal has been thoroughly emptied before the operation by the use of four tablespoonfuls of castor oil these remedies may be employed in reasonable amounts with great benefit to the patient and entirely without danger.

It is this tendency to decomposition in place of digestion of food given by mouth shortly after an operation, which makes it virtually of no use to the patient, because he obtains no nourishment from the food so taken, while the absorption of the products of decomposition is a real injury. There is, of

course, the further advantage in this feature of the after-treatment that it secures a condition of rest for the tissues which have been subjected to traumatism, which in itself is of very great importance.

APPENDICITIS

In the consideration of this subject we will take a number of cases which have come under care and follow them through the various stages of their disease, precisely as they progressed, which will doubtless give a much more satisfactory idea of the plan of treatment we would advise than in describing the treatment without reference to actual clinical cases.

CHRONIC RECURRENT APPENDICITIS

Typical instance. A patient forty-four years of age, a machinist by occupation, gives the following history: Ever since he was a boy he has had occasional attacks of severe colicky pains in the abdomen. These were always accompanied by nausea, never by chills or vomiting. From the age of twenty to thirty-two he always carried some morphine pills, which he took during these attacks, which never lasted more than a few hours. At this time a diagnosis of gall stones was made. He always abstained from taking food during the attack and ate sparingly for a week or two following. At times the attacks occurred every week, then they would disappear for a month, then for six or eight months, and between the ages of thirty-four and forty-two he was entirely free from actual attacks, but constantly suffered from digestive disturbances. Fifteen months ago he had a recurrence which was more severe than any he could recall. It compelled him to remain in bed for several days and left a point in the right inguinal region which was tender upon pressure. Since that time he has had eight attacks, each one a little more severe than the previous, and each sufficiently severe to prevent him from going to his work for from three to ten days. His last attack commenced ten days ago and he has been confined to bed during this time, although he has not been severely ill. During these attacks he has abstained from food for the first two to five days, and after that he would take soups and milk.

He is a slightly built man, muscular development good. Heart, lungs, liver and kidneys normal; abdomen soft. Upon inquiry he points to the right inguinal region as the seat of his trouble. Nothing abnormal can be found here except pain upon deep palpation. This also reveals an area of induration, which is, however, very small. His temperature is below 100° F., pulse 88, tongue coated.

One peculiarity to which the patient directs attention is the fact that during the early attacks the pains were spasmodic and came in waves. The patient describes them as though something were grasping a tender portion of his intestine and squeezing it and then loosening the grasp, only to tighten again. During the past two years this condition has changed and now the pain is more constant and dull.

We would explain the peculiarity regarding the character of the pain by the change in the tissues of the appendix. The muscular coats have suffered severely and do not respond to irritation as they did at first, consequently the spasmodic character of the pain has disappeared.

This is not at all an uncommon history. An individual formerly in apparently perfect health and able to perform hard labor, suffers for a period from a moderate disturbance of the digestion; then there is an acute attack of appendicitis from which the patient recovers only to find the digestive disturbance exaggerated. He returns to work, but soon has a second acute attack of appendicitis, from which he again recovers, only to repeat his former experience. If he has his own business, or is engaged in the pursuit of a profession, he soon falls behind his competitors and is compelled to make great sacrifices. If he is in the service of others his employer will soon replace him by a man who can be depended upon.

Prognosis. Many of these patients have been encountered suffering from chronic recurrent appendicitis whose prospects in life have been ruined on

account of their disease. This, in itself, is an ample indication for radical treatment, provided that it will not result in complications and is not connected with much danger, but is likely to result in a permanent cure.

There are yet other valid reasons why an attempt should be made to relieve the patient permanently. *With each successive acute attack he is exposed to a certain amount of danger to life.* The fact that a patient has recovered from several attacks does not indicate that he will always in the future be so fortunate. *Each attack undoubtedly exposes the patient to much more danger than would an operation for the removal of the appendix.*

Moreover, the fact that his digestion is becoming more and more impaired is certain to affect his chances for a long life. It is likely that this indigestion results in the absorption of a considerable amount of products of decomposition. In the same way, septic material is likely to be absorbed from the lumen of the obstructed appendix.

That a permanent cure is to be looked for, after the removal of the diseased appendix, we know from clinical experience. The conditions for operation are so favorable that complications or unfavorable secondary effects are not to be expected. The general condition of the patient is fair, his temperature and pulse are normal, he is not suffering from an acute infection. It has been possible to empty the intestines thoroughly before the operation, which will facilitate the operation and the recovery. It will not be necessary to cause much traumatism, and any abrasions which may occur in loosening adhesions can readily be covered with peritoneum. It will not be necessary to drain the abdominal wound or to make this especially large, hence there need be no fear of the occurrence of a ventral hernia. Consequently we can reasonably eliminate the fear of complications.

Concerning the danger of the operation we would say that in our own experience there has been a mortality in cases like the one outlined of less than one in five hundred, or one-fifth of one per cent., and such mortality rests upon accidents which might occur with the simplest operation of any kind.

For these reasons we advise the removal of the appendix in cases of which the above is a type.

Technique. We wish to direct attention to the fact that such a patient's abdominal walls are loose and that the intestines are not at all distended with gas. This is due to the preparatory treatment consisting in the administration of two ounces of castor oil twenty-four hours before and a sterilized liquid diet for the same period.

The field of operation being prepared in the usual way is separated from the remaining portion of the surface of the body by means of sterilized towels, a sufficient amount of space being left free so that all the manipulations necessary during the operation may be carried out without disturbing the towels, for we must not carry any infectious material from the lower surface of these towels to the seat of operation.

Abdominal wound. The incision is made parallel with Poupart's ligament, shown in the accompanying plate, crossing a point half way between the anterior superior spine of the ilium and the umbilicus, so that one-third of the incision will be toward, and two-thirds from, the median line of the body as regards the above point. This incision is carried down through skin, fascia, fat and the external oblique abdominal muscle and fascia, splitting the fibers of the latter with the blunt end of the scalpel. The cut through the external oblique may be made an inch shorter than that in the skin and it will still furnish a sufficient amount of space. The edges are now retracted and the direction of the fibers of the internal oblique abdominal muscle may be seen at right angles to the incision. These fibers are also separated without cutting, and we

expose the strong transversalis fascia, which is closely attached to the peritoneum. This is picked up between two pairs of dissecting forceps, one in the surgeon's hand and one in the hand of an assistant. It requires a little care to avoid picking up omentum or intestines at the same time, but by lifting the transversalis fascia with one pair of forceps, then picking it up with the other, then changing the position of the first pair slightly, any intestine or omentum which may have been included at first is likely to be dropped. The transversalis fascia and the peritoneum are incised carefully.

Guides to the appendix. The omentum immediately comes into view crowding itself into the opening to protect the underlying intestines. When this is pushed to one side the cecum is exposed. This can be recognized by the band of longitudinal muscles extending along the anterior surface of this portion of the intestine. Following this band downwards invariably leads to the appendix. By bearing these facts in mind it is possible to find the appendix with the slightest amount of disturbance of the abdominal organs; the manipulations being confined to a very small area. Where repeated recurrences, with their acute inflammatory disturbances, have resulted in extensive adhesions, the appendix may be club-shaped at the end and somewhat bent upon itself. Its proximal third may be loosely adherent to the lower end of the cecum, while the remaining portion is strongly adherent to the anterior surface of the iliacus muscle.

Adhesions. In separating adhesions it is always necessary to exercise the greatest care, because occasionally a small abscess may remain for a considerable period of time after an acute attack of appendicitis, and if the appendix is peeled out carelessly it is very possible for the pus to come in contact with other parts of the peritoneal cavity and a peritonitis may then occur. Again, a perforation into the cecum, or the ileum, may have occurred during an acute attack and the communication between the lumen of the appendix and the intestine may not have healed entirely, and upon removing the appendix a small intestinal fistula may be left, which again may become the cause of peritonitis. In case there is an attachment to the cecum or ileum the surface from which the appendix has been removed should be covered at once by means of a few Lembert sutures.

Again it may happen that the lumen of the appendix at its cecal end is occluded and that the sac which is thus formed is filled with pus. Unless great care is exercised in dissecting the appendix out of its adhesions it is liable to perforate during the operation and cause an infection.

Prevention of peritoneal adhesions. Recently various methods have been recommended for the prevention of post-operative peritoneal adhesions, especially in the presence of drainage tubes.

Our experience has not been sufficient with any of these to warrant definite statements. We have placed cigarette drains composed of gauze surrounded by rubber tissue in many cases with apparent success. We have also filled the peritoneal cavity with 5 per cent. citrate of soda in normal salt solution, also sterile liquid vaseline. We have not made use of a solution of herudin which has been mentioned very favorably by many experimenters, neither have we made use of adrenalin solutions. It has seemed to us that absence of even the slightest unnecessary traumatism is of the very greatest importance and far outweighs all other possible elements.

Removing the appendix. The removal of the appendix may now be accomplished as illustrated. (1) A pair of forceps is applied to the mesentery of the appendix. (2) The mesentery is severed between the appendix and the forceps. (3) Two pairs of forceps are applied to the appendix at the point of its origin from the cecum. (4) The mesentery of the appendix is ligated and the forceps holding this structure is removed. (5) A purse-

string stitch is applied from one-eighth to one-fourth of an inch from the base of the appendix. These steps are shown in the accompanying plate, although in practice the forceps on the mesentery is removed before the purse-string suture is applied. The presence of the forceps on the appendix facilitates the application of the purse-string suture and at the same time acts after the fashion of an angiotribe, crushing the tissues of the appendix into a thin layer, as shown.

The appendix is now cut away even with the forceps, care being taken to prevent leakage by applying another pair of forceps half an inch nearer the distal end of the appendix before cutting it away. The crushed stump of the appendix is then grasped by a pair of smooth dissecting forceps, or with a probe containing a fine, short needle at its end, and inverted into the cecum while an assistant draws the circular stitch tightly, thus closing the defect. The defects caused by the removal of the appendix are then covered with peritoneum by means of a few fine silk sutures and then a few more sutures are applied to cover the space occupied by the purse-string suture. It is not always that these last stitches are essential, but a little too much care is excusable, so long as it is harmless.

Ligatures and stitches. In some cases the stump is very vascular, which may make it desirable to apply a fine, catgut ligature to its crushed end, but this is not usually necessary. In applying the purse-string suture the needle should take a sufficiently deep bite to include all the layers down to the mucosa, the connective tissue next to the mucosa being the most important layer.

It does not matter whether fine silk or fine catgut be employed for these sutures, but in our own practice fine silk is used for all sutures applied to the intestinal walls. As a matter of convenience we use an ordinary straight sewing needle or a fine curved needle with the fine silk double, in order to prevent twisting and unthreading, because the sutures may be applied more rapidly in this way than by sewing with a single thread.

The entire field of operation is carefully inspected once more and if any abrasion is found this is covered with a few Lembert sutures, then the intestine is dropped into the peritoneal cavity, and the abdominal wound closed in the following manner:

Closure of the abdominal wound. The peritoneum and transversalis fascia are first caught with forceps and then united by means of a continuous catgut suture. In this part of the abdominal wall the transversalis fascia is strong and is sometimes likely to retract so that it is quite liable to be overlooked. As this error would weaken the abdominal wall quite a little at this point, it is well to bring both the peritoneum and the transversalis fascia together carefully with this suture.

The edges of the internal oblique muscle fall in apposition spontaneously as soon as the peritoneum and transversalis fascia have been sutured, and without any further interference there would probably be a perfect union in the layer. To insure this still more fully, however, we apply one or two, or even three, interrupted catgut sutures through this muscle. It is important to tie these sutures very *loosely*, as pressure-necrosis in this position would result in retraction of the muscle and this would, of course, produce a marked weakening of the abdominal wall at this point.

The edges of the wound in the external oblique muscle and fascia have been held apart by means of retractors, in order to expose the internal oblique thoroughly. These retractors are now removed and immediately the edges of the muscle and fascia approach each other. With this natural tendency of the edges in wounds of these two muscles to approximate themselves without the use of sutures, there need be no fear of the formation

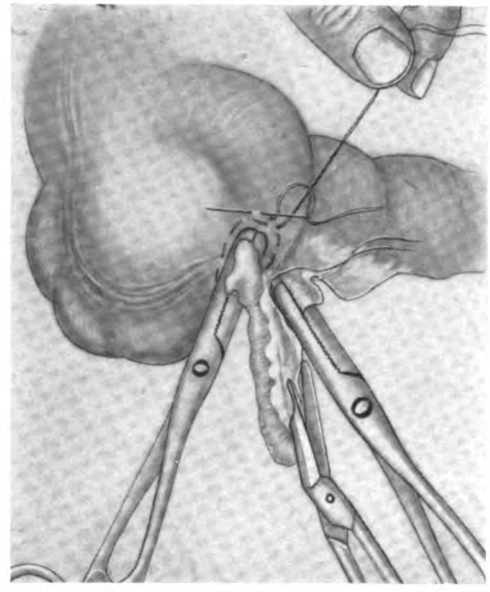
a post-operative hernia, because these two strong layers extend at right angles to each other.

The edges of the wound in the external oblique muscle are now united, as illustrated, care being again used not to draw the stitches too tightly for the reason given above.

In the three plates just referred to (see following pages), deep silkworm gut sutures are figured as placed in position, but not tied. These may be used if desired and tied after the buried sutures have been applied, but they are not necessary to secure a perfect union (and unless there is an unusual amount of tension in any case we do not use them, depending entirely upon the catgut sutures). In the next plate these stitches are figured as having been tied and the skin is being united by means of a continuous, buttonhole stitch of horsehair. The latter is again used double, in order to prevent unthreading of the needle. It does not matter what form of stitch, or what material is used, for the coaptation of the skin so long as the material is aseptic. A dressing of aseptic gauze is applied to the surface and held in place with broad rubber adhesive plaster strips, in order to support the abdominal wall. This is covered with a sheet of sterile absorbent cotton which is held in place with an abdominal binder.

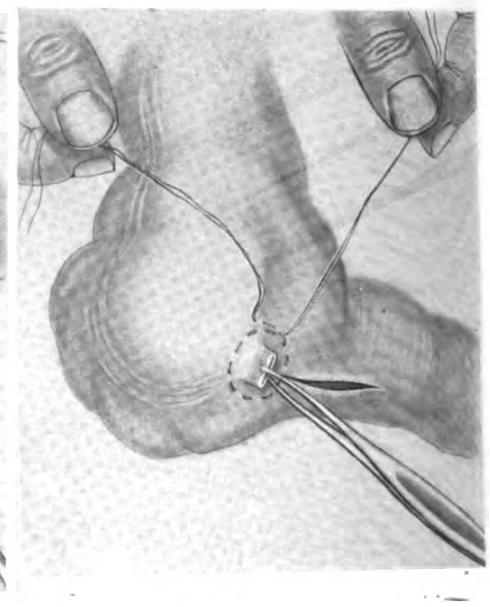
Pathological appearances of the appendix. The specimen is a little over four inches in length, which is considerably less than it was before its removal, because the longitudinal muscle fibers have been contracted, and this has resulted in a marked shortening of the organ. Its mesentery is quite thick and extends a little beyond the end of the appendix. This condition has probably served to protect the organ against more extensive destruction, because in this way a fair blood supply has been insured to the entire part, although locally it may have suffered severely. About one-half inch from its cecal end there is quite a marked narrowing in the lumen, and by inspection and palpation one may determine the presence of a considerable amount of cicatricial tissue at this point. The narrowing is shown in the plate. Beyond this constriction we feel several hard masses in the lumen of the appendix which are undoubtedly due to fecal concretions. Upon laying open the part, these concretions show, by the irregular forms into which they have been molded by the irregularities in the lumen of the appendix, that they must have been in this portion for a considerable period of time. The mucous lining of the appendix shows a number of cicatrices resulting from ulcers which have healed, and at the narrowest point, near the cecum, the entire wall seems to be composed of cicatricial tissue, showing that there must have been at some time a complete destruction of a portion of the wall of the appendix. The lumen at this point is so small that a slight edema would suffice to close it entirely, and with this closure would disappear the drainage of the cavity of the appendix. The septic material present in this lumen would, of course, increase very rapidly so soon as drainage had completely disappeared, and this would result in a recurrent attack.

The digestive disturbances with which such a patient is afflicted can be explained, first, from the interference with the fecal circulation because of the extensive adhesions drawing the intestines out of place; second, from the fact that the ileo-cecal valve prevents the passage of gas and feces when there is an irritation or inflammation in the appendix, and consequently the constant inflammation in this organ, for perhaps a number of years, results in an almost constant obstruction to the passage of gas and feces from the ileum into the cecum, and this, of course, causes digestive disturbances.



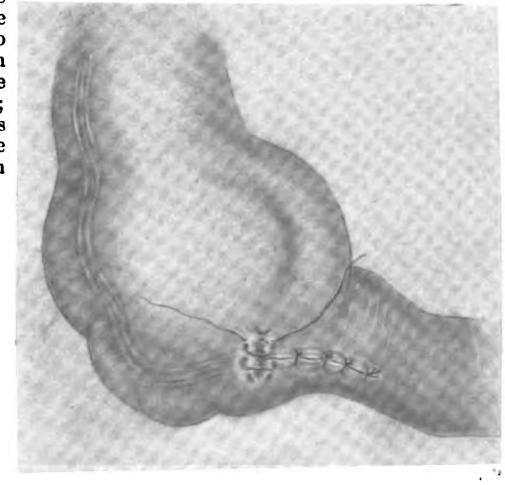
EXCISION OF APPENDIX.

Represents the excision of the vermiform appendix, a clamp being placed at the base of the appendix, a second one upon the mesenteriolum; a ligature is in position to tie the mesenteriolum; the scissors are in position to cut the mesentery between the appendix and the clamp upon the former; a purse-string suture has been placed about the base of the appendix upon the end of the cecum.



CECUM WITH APPENDIX REMOVED.

Represents the end of the cecum after the appendix has been cut away, the remaining portion showing the effects of the pressure from the clamp. The figure should show the mesenteriolum ligated and cut, instead of showing a slit in the peritoneum, covering the cecal end of the ileum.



EXCISION OF APPENDIX.

Represents the appendix buried by a second row of sutures. The longitudinal muscular band is shown to extend down to the origin of the appendix in each of these drawings of the cecum.

Atypical conditions. In many of these instances of chronic recurrent appendicitis it is much more difficult to remove the appendix than has just been stated, because it may be located in some position from which it can be dissected only with great difficulty. A not uncommon location is on the posterior surface of the cecum. Here it is frequently completely covered with adhesions.

In these cases the end is usually club-shaped and filled with fecal material, pus or mucus. Frequently there has been a perforation between the appendix and the cecum, and occasionally there is a fistula which has persisted for a long time. The cecum, together with the appendix, may be united by adhesions to the anterior surface of the iliacus muscle or to the omentum, or to both. The appendix may also be displaced very greatly. It has been found attached to the left of the median line, even to the border of the spleen. We have found it attached to each of the pelvic organs, uterus, bladder, ovaries, tubes, sigmoid flexture and rectum; also to the small intestines, to the anterior abdominal wall and to the gall bladder. Indeed, with a long, free cecum there is no reason why the appendix should not be found attached to any point within the abdominal cavity.

Many times we have seen the appendix twisted upon itself like a snail and held in this position by adhesions, making the evacuation of its cavity practically impossible. In many cases there are several strong adhesions at various points in the course of the appendix, making short bends, which have a tendency to obstruct its lumen. The distal end of the appendix may project beyond the last one of these adhesions and form a free, sac-like projection.

It frequently happens that the strong adhesions are located opposite a point at which there was a perforation in the appendix during an acute attack. This will, of course, still further obstruct the lumen at this point.

Occasionally an appendix is found in which the greater portion of the structure has been destroyed by gangrene and has been absorbed, leaving only a small, string-like structure along the edge of the mesentery of the appendix. Again, the cecal end may have been destroyed in the same way, leaving the distal end without communication with the cecum. This condition is likely to be troublesome because it leaves a sac, lined with mucous membrane containing septic material, without drainage into the cecum.

In still other cases the appendix has become so intimately united with the posterior surface of the cecum that it can be discovered only after the most careful search has been made, because both the appendix and the underlying cecum are covered with a broad sheet of connective tissue, which has almost perfectly the appearance of peritoneum. In these instances it frequently happens that the proximal end of the appendix is entirely occluded and that the distal end contains septic material which gives rise to the recurrent attacks of appendicitis, which subside only when the abscess formed has perforated into the cecum.

The longitudinal band of muscle fibers serves better than any other guide to the discovery of the location of the appendix in these examples.

The operator may easily be deceived in searching for the appendix, in the interval in recurrent appendicitis, by the presence of a small mass of fat at the lower end of the cecum. This may lead him to suppose that the appendix has been entirely destroyed on account of gangrene and that all that is left is simply the fat mesentery of the appendix. Careful inspection will usually show that this mass of fat consists of a small portion of omentum which has surrounded the appendix and has become thoroughly adherent to the latter or to its remnant after the portion destroyed by the disease has been absorbed. So long as the operator follows the longitudinal muscle

band upon the anterior surface of the cecum, and at the same time is as careful as possible not to injure the walls of the loops of intestine which may be adherent, his search for the appendix may be conducted with relative safety.

Important conclusions. The important points to be borne in mind in connection with recurrent appendicitis are: 1, The patient's opportunities for professional or business prosperity are greatly limited by the frequent interruptions due to the disease. 2, He is deprived of many of the ordinary pleasures of life. 3, He is constantly in danger of suffering from a serious attack. 4, His digestion is impaired and his nutrition is correspondingly reduced. 5, He is forced to absorb septic material during a considerable portion of the time. 6, During any attack any of the various complications resulting from acute appendicitis may occur. 7, So large a proportion of these cases suffer from gall stones that this condition may be reasonably looked upon as being secondary to the appendicitis in some instances.

All of these conditions can be eliminated by an operation which in itself is not accompanied with as much danger as there is in any one attack of recurrent appendicitis, and which will confine the patient for a very short time, provided, always, that the operation is performed by a safe surgeon and after the acute attack has subsided completely.

ACUTE PERFORATIVE APPENDICITIS

Typical history. The patient is fourteen years of age, a school-girl slightly built, and not well developed for her age. She has never been strong since infancy, which she attributes to the fact that she suffered from measles and scarlet fever while very young. Her nutrition has always been imperfect and her appetite unnatural, being either ravenous or entirely absent. Her bowels have been constipated and abdomen bloated. She has menstruated since one year ago at irregular times and has suffered severely from pain in the region of the right ovary during each period. The pain has been spasmodic and so severe that the use of anodynes seemed necessary for her relief. She never suffered from severe pain at any other time, although she occasionally had slight attacks of colic in the epigastric region whenever she was especially careless about eating. Three days ago, immediately after an unusually large dinner the patient suddenly experienced severe pain over the entire abdomen, but which was more intense in the vicinity of the umbilicus.

The patient was put to bed and hot cloths were applied to the abdomen, affording only slight relief; she was then given a large dose of salts, followed by a cup of hot water. Being slightly nauseated before, this condition increased very rapidly, resulting in severe vomiting, which has persisted at intervals ever since. Two days ago she received several enemata, one of which was followed by the expulsion of gas and some feces. The patient received soups and milk by mouth, but could not retain the nourishment more than a few hours at a time, when she would vomit whatever had been taken. All remedies administered to relieve the nausea and vomiting were of no avail. Several further enemata were given without effecting the expulsion of gas or feces. The abdomen became more and more tympanitic and the pain became so severe that morphia had to be used hypodermically. The pulse increased to 130 beats per minute and the temperature to 102.5°. The pain has become localized in the right inguinal region.

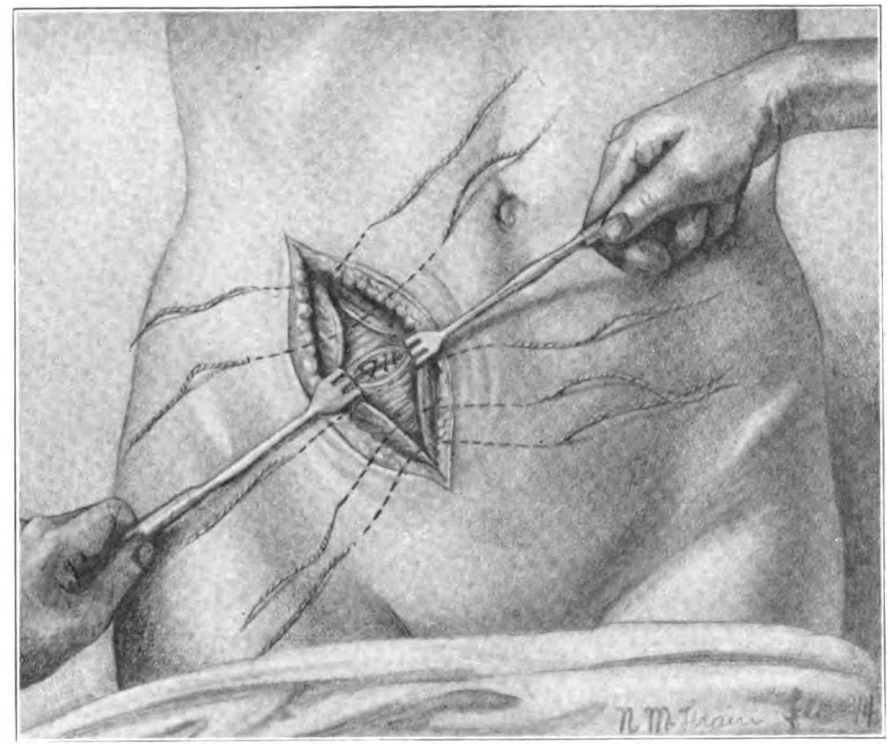
The general appearance of the patient is extremely unsatisfactory. She gives the impression of one who is almost hopelessly ill. She has an anxious, restless expression. Her breathing is entirely costal, rapid and short. Her abdomen is severely distended and more prominent in the right inguinal region than in the left. The abdominal muscles are exceedingly tense, especially on the right side. The patient shrinks if she notices any one approaching the bed, although she seems too ill to show interest in anything else.

Upon percussion we find a little difference in resonance in the two inguinal regions, but neither side gives a dull or a flat sound. The patient complains of pain from percussion on the right side.

Upon examination through the rectum we find this organ distended with gas above the internal sphincter, which is supposed to indicate the presence of diffuse peritonitis. On the right side the finger perceives a fullness, but no fluctuation. Her thighs are drawn up to relieve the tension of the abdominal muscles. The nurse has placed a pillow under her knees to make this position more comfortable. The patient's temperature is nearly 103° F. and the pulse 130 beats per minute and very feeble. Her tongue is thickly coated and the edges are red in small spots. She is intensely thirsty, but does not retain the liquid given to her.

The patient is evidently suffering from acute perforative appendicitis with beginning diffuse peritonitis. This may be due to the perforation of an ulcer which has existed for a considerable period of time, or to gangrene of the appendix, from thrombosis of some of its vessels, or to the perforation of an appendix distended with pus with its cecal end occluded by cicatricial tissue. The patient is extremely ill, and it is plain that unless the method of treatment employed during the past three days is radically changed she cannot survive long.

Considerations of treatment. So far the patient has received the treatment prescribed by many of the leading text-books on internal medicine. She has been limited to liquid diet, has received saline catharties and enemata, has



CLOSURE OF WOUND OF MCBURNEY'S INCISION FOR THE REMOVAL OF THE VERMIFORM APPENDIX.

The incision is parallel with Poupart's ligament. Its center is in the line drawn from the umbilicus to the anterior superior spine of the ilium and half way between these two points.

The aponeurosis of the external oblique abdominal muscle is shown split parallel with its fibres in the direction of the skin wound.

The internal oblique abdominal muscle is split in the direction of its fibres at right angles with the direction of the wound in the skin. Sutures have been applied to the transversalis fascia and peritoneum and deep silkworm gut sutures have been inserted through all layers down to, but not through, the peritoneum. A few catgut sutures are to be applied to bring the edges of the internal oblique abdominal muscle together, and a continuous catgut suture for the purpose of uniting the aponeurosis of the external oblique abdominal muscle.

The skin is sutured with horsehair or silk and then the silkworm gut sutures are tied over all. It is, however, quite safe to omit the silkworm gut sutures altogether.

had hot applications to the abdomen, and when the pain has been unbearable opium was employed only in sufficient doses to overcome the severe distress.

There can be no doubt from the progress of the disease that such treatment was extremely unfortunate in this case. We believe that this form of treatment should be condemned in every case of acute appendicitis, because it contains nothing which can be useful for the relief of the pathological conditions

present, while it includes many features which are extremely harmful, as we shall see presently.

The giving of cathartics of any kind during acute gangrenous or perforative appendicitis at any time during the attack has undoubtedly destroyed more lives than surgery has saved in this disease.

The question arises, What can we do for this patient that will be of greatest benefit to her and may possibly rescue her from the present apparently hopeless condition?

Many authors advise an immediate operation in all cases of acute appendicitis without regard to the condition of the patient or the stage of the attack, unless the patient is moribund on the one hand or improving rapidly under the treatment which is being employed at the time the surgeon is called.

Although this patient is very ill, she is not moribund, consequently this case would come under the class in which an immediate operation is advised by these authorities. In our experience, and in that of all surgeons whose work we have had an opportunity to observe, patients with the conditions of the case described have almost invariably died within twenty-four or forty-eight hours after the operation. They therefore belong to a class in which operative treatment has an especially high mortality. In fact, by far the greater portion of all fatal cases following appendicitis operations belong to this class. These cases have been said to be too late for an early, and too early for a late operation.

Our experience has been quite different with a form of treatment which we will proceed to set forth. Of course, no form of treatment can save every case of perforative appendicitis, especially if the patient has received cathartics and food by mouth before he comes under care, but in cases like the one depicted we would estimate the proportion of recoveries at about ninety per cent. if the method which we recommend be employed.

Taking all cases of gangrenous and perforative appendicitis together, as a class, as they come under our care at the hospital, those that are like the case named and those that are not so severe but still having gangrene or perforation present, and those that are still worse, our mortality is now a little less than two per cent.

Had it been possible from the beginning to confine the septic material to the vicinity of the appendix, the patient's condition would never have become as serious as at present, because her serious condition is undoubtedly due to the fact that the septic material has been distributed over a considerable portion of the peritoneum, as a direct result of peristaltic motion of the intestines caused by the giving of food and cathartics by mouth.

Anatomical surroundings of the appendix. In order to comprehend fully the treatment we advise in this class of cases, it will be necessary to direct attention to the anatomical location of the appendix.

The appendix is virtually surrounded on all sides, excepting in the direction of the median line, by relatively fixed tissues. Above we find the lower end of the cecum and the cecal end of the ileum; to the right and in front is the parietal peritoneum; behind the peritoneum covering the iliacus muscle; and toward the median line it is surrounded by loops of small intestines. Moreover, the omentum extends far beyond its lower end. (In small children the omentum is so slight in many cases that it cannot be considered of great value in protecting a gangrenous appendix.)

It is true that the appendix may be displaced downward, but in this event it will again be surrounded by fixed tissues which seem especially adapted to dispose of septic material. Again, there may be an enteroptosis affecting the cecum, and always with this a marked lowering of the transverse colon and stomach, and with these, the omentum.

The twelve colored illustrations shown here give practically all of the more usual forms of appendicitis which one is likely to encounter.

Fig. 1 shows an appendix with a side, funnel-shaped, cecal end, the entire appendix tapering uniformly from the point of its attachment to the cecum. Appendices of this form, in our experience, are likely to give rise to digestive disturbances. Apparently fecal material is forced into these appendices and is forced out again without giving rise to serious symptoms, because an obstruction is quite unlikely to occur. The irritation of this process, however, is liable to incapacitate the patient to a marked extent. The removal of the organ is usually followed by prompt relief.

Fig. 2. This appendix is narrow at the cecal end and club-shaped at its distal end. It may give rise to mild septic symptoms which are usually followed sooner or later by gangrene of the mucous membrane or of a greater or smaller portion of the entire appendix. The condition is very much more serious than that illustrated in Fig. 1.

Fig. 3. In this case the cecal end of the appendix is almost completely covered. The distal end, besides being club-shaped, is curved upon itself like a shepherd's crook. Patients suffering from appendicitis in this form, although they may recover spontaneously, are never entirely well until the appendix has been removed, because its distal end constantly contains septic material.

Fig. 4. This appendix has two constricted portions, one near its cecal end, and one a little beyond its middle, showing that at some time the mucous membrane must have been gangrenous and sloughed away, leaving two portions of the lumen containing mucous membrane or septic material. A patient with such an appendix will also not be well until it is removed.

Fig. 5. This appendix is curled upon itself like a snail. There is a sheet of connective tissue tying it down. The cecal end is narrow. Patients with such an appendix are never free from discomfort.

Fig. 6 shows an appendix with a perforation of its distal end. This type corresponds to that shown in Fig. 2, with the addition of the gangrene which has evidently supervened.

Fig. 7 shows a fairly common type of chronic appendicitis obliterans, in which the cecal end is funnel-shaped, while the distal two-thirds of the very long appendix is almost entirely cicatricial in character.

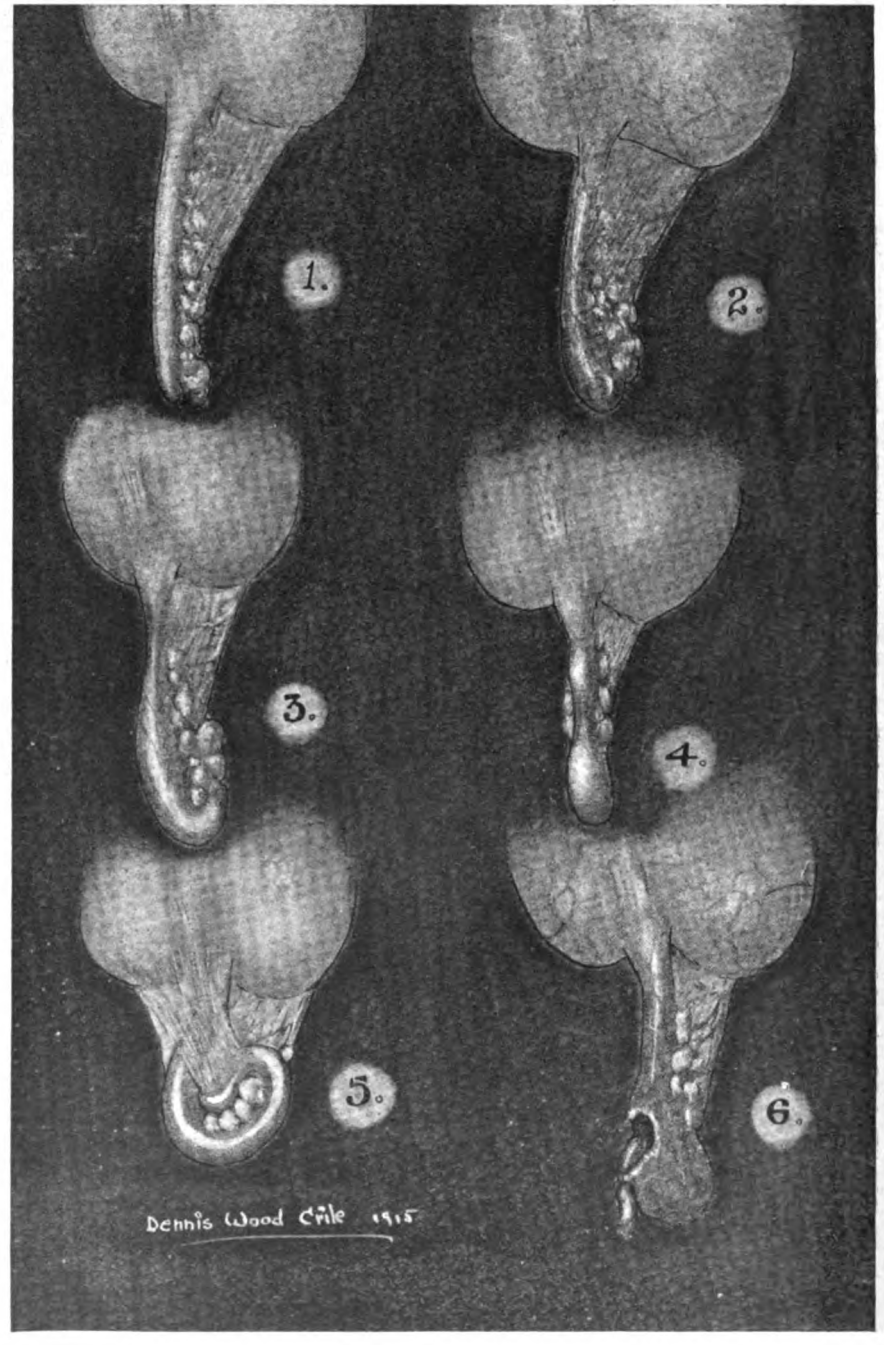
Fig. 8 shows the end of the cecum with a fragment of the ileum and an almost completely destroyed appendix bound strongly to the lower end of the cecum by means of connective tissue. In case there is still a slight amount of mucous membrane left in an appendix of this type, the patient may continue to be in a slightly septic condition for months or years, which will disappear immediately upon the removal of this structure.

Fig. 9 represents an enormously distended, short appendix whose walls are many times the normal thickness. The mucous membrane in these cases is covered to a greater or lesser extent with granulation tissue. In case the cecal end is occluded because of the thickness of the wall and the presence of granulation tissue, the distal end may be distended with mucous or pus, and it frequently contains fecal concretions. Patients suffering from this condition usually have frequently recurring attacks which not infrequently end in perforation.

Fig. 10 represents a short, thick-walled appendix with a fecal concretion lodged in an ulcerated area with beginning gangrene of the surrounding mucous membrane. This appendix is widely open at its cecal end, making continuous drainage into the cecum possible.

Fig. 11 represents an appendix with similarly thickened wall. An ulcerated area is present near its distal end, containing mucous and pus, but no concretion. The appendix is narrowed at one-third its distance from the cecal to the distal end, to such an extent that the lumen of the distal end cannot be drained into the cecum. In case the mucous membrane of the narrowed portion is edematous because of acute inflammation, there is great danger of perforation.

Fig. 12 shows an appendix with thickened wall and gangrenous mucous membrane, which is in great danger of perforation.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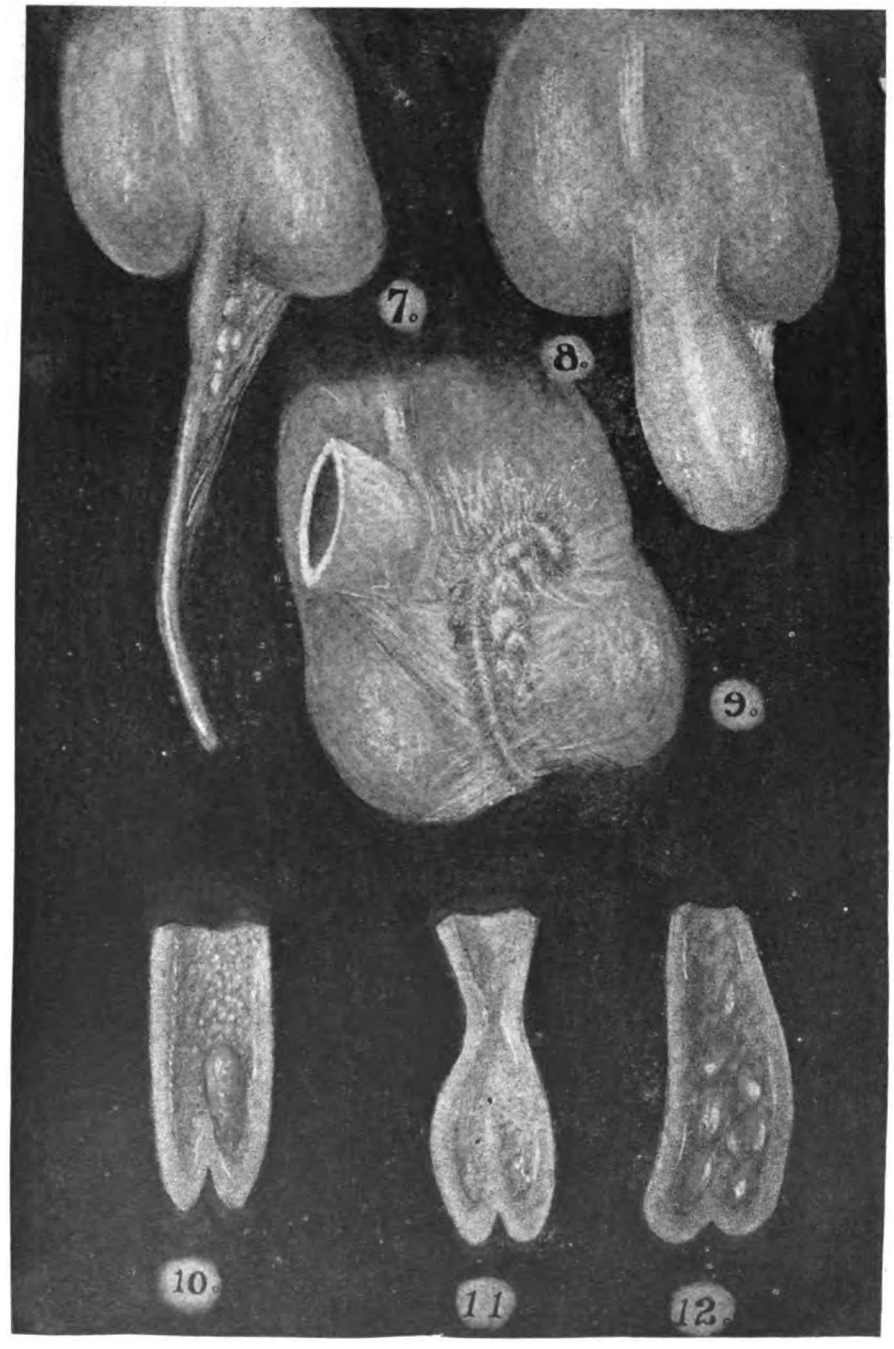
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It may also be displaced upwards and backwards in which instance the cecum is in a position to furnish perfect protection; or upwards and forward when the omentum will be able to surround it on all sides.

Thus we see that the natural anatomical arrangement for the protection of the general peritoneal cavity is extremely efficient. There is but one weak point in the anatomical provision for this protection, namely, in the direction of the median line, because the great mobility of the small intestines naturally favors the distribution of septic material to all parts of the peritoneal cavity. If we can prevent the small intestines from doing harm in this direction, we will have accomplished our end, theoretically at least.

At this juncture let us direct attention to another important anatomical condition. The blood supply of the omentum is so enormous that it will readily dispose of a very severe infection by walling off the surrounding structures if it is permitted to give its physiological attention to a single area.

It is a well-known fact, which every one who frequently operates during the acute attack of appendicitis has had many opportunities to observe, that the omentum crowds itself about any inflammatory or traumatic lesion within the peritoneal cavity the moment such lesion occurs, and if left undisturbed a few hours will suffice to cause efficient protective adhesions. *These adhesions become stronger every hour and the blood supply in the omentum becomes greater, so that if no disturbance arises one can reasonably expect efficient protection to the general peritoneal cavity from the omentum.*

Another important fact must not be lost sight of in this connection, viz.: that the surrounding structures being relatively fixed in position favor the condition of rest of the inflamed part and permit the omentum to act after the manner of a splint applied to an inflamed joint. The value of rest as a preventive to the extension of an infection in any part of the body cannot be overestimated. Consequently, if it is possible for us to secure this condition of rest we have gained another important point in the right direction.

Should the appendix be displaced upwards its position is even more favorable, because the available amount of omentum is thus increased. Again, if the appendix is retro-cecal in its position, which is very frequently the case, the infection of the general peritoneal cavity is more easily prevented than when in its normal location. If anteriorly misplaced it is likely to be fastened to the anterior abdominal wall by the adherent omentum.

Peristaltic motion of the small intestines. It is plain, then, that the infection of the general peritoneal cavity must occur from a disturbance on the part of the small intestines and must be due to their peristaltic motion.

It is significant that in almost all cases of severe, acute appendicitis the obstruction to the passage of gas and intestinal contents through the ileo-cecal valve is one of the early symptoms, a condition which was present throughout the attack in the case typified. Nature is trying to prevent this very dangerous disturbance by closure of the ileo-cecal valve. We have a condition corresponding to the contraction of the muscles surrounding an inflamed joint: to the closure of the eye-lids in conjunctivitis, etc. Moreover, the muscles overlying the appendix becomes tense. Everything tends toward the establishment of conditions of *rest* in the vicinity of the inflamed organ.

The effect of the introduction of any kind of food or cathartic into the stomach. It is a fact which has been demonstrated a great number of times that peristalsis does not occur unless food or cathartics are introduced into the stomach. If the attack occurs shortly after a meal and before all of the food has passed through the ileo-cecal valve, its presence may cause peristaltic motion in the small intestines. Upon reaching the ileo-cecal valve the latter may prevent its passage into the cecum, causing return peristalsis, and the intestinal contents are forced back into the stomach, from which cavity again to be expelled by vomiting, or again forced into the small intestines,

giving rise to further peristaltic motion. Moreover, it will give rise to the formation of gas, which must cause disturbance and pain in its attempt to pass the ileo-cecal valve.

This motion, it is plain, will be harmful primarily from the fact that it gives rise to pain by disturbing the sensitive, inflamed tissues; and, secondarily, from its likelihood of carrying infectious material, with which the intestines or the omentum have come in contact in the vicinity of the inflamed appendix, to other parts of the peritoneal cavity.

Besides this the physiological attention of the omentum cannot be directed to the single area of infection, because other parts of the peritoneal cavity require its protection, and such portions of the omentum as are not yet thoroughly adherent about the inflamed appendix are inclined to be diverted from this point.

Theoretically, then, the disturbance which is to be feared to so great an extent is caused by the presence of food or cathartics in the stomach and intestines, and its logical remedy would be to absolutely prevent the introduction of any form of food or cathartics into the stomach and the removal by gastric lavage of any portion of food that may be retained in the stomach at the beginning of the attack. It may be necessary to perform gastric lavage twice, or at most three times, in order to entirely remove remnants of food which may have regurgitated into the stomach from the small intestines by reason of return peristalsis. That this is not only true theoretically, but also in practice, we have demonstrated in a large number of cases; and many other surgeons who have followed the same plan of treatment have informed us of the fact that their experience has agreed with ours.

Cause of failures. It is true that a few surgeons have reported failures with this method, but an investigation of their treatment in each instance has shown that they disregarded one of the three cardinal points in the treatment. They either gave just a little liquid food by mouth, or they gave some form of cathartic, or disturbed the rest of the intestines by giving large enemata, or they neglected removing the stomach contents by gastric lavage.

Of course, the slightest amount of food is sufficient to start peristaltic motion of the small intestines, and the same is true of cathartics, and consequently if either of these features in the treatment be omitted one cannot hope for the same results. Even water given by mouth will frequently start peristalsis, and when given rapidly by rectum in the form of enemata the same harmful effect is often experienced, while this is not the case if normal salt solution be given by rectum continuously by the drop method introduced by Murphy.

Starvation plan of great value unqualifiedly. It seems clear that this plan of treatment must be useful, in any given case, no matter what form of appendicitis may be present, because in the milder cases it will result in rest of the affected part, and consequently rapid resolution; in the severe cases it will guard against mechanical distribution of infectious material; and in all cases it reduces the tendency to meteorism and stops the pain.

We wish, therefore, once more to impress every one who reads this with the important fact that no matter what form of treatment he may have decided to carry out in any given case of acute appendicitis his patient will be safer and more comfortable and will make a more rapid recovery with fewer complications, if he makes use, in addition to the treatment contemplated, of the plan just described.

A great change in mortality. There is, particularly, one class of patients in which we have found this treatment of the greatest value. We refer to the class in which the appendix is gangrenous or perforated and in which there is already a beginning general peritonitis. These patients give the impression of being profoundly ill. There is complete obstruction to the passage of gas and

feces. There is nausea or vomiting and marked meteorism; the pulse is small and quick; usually there is high fever, but the temperature may be subnormal; respiration is rapid, superficial and costal, and the abdominal muscles overlying the appendix are tense—conditions corresponding to those we have just clinically outlined. The patient is in a state in which we formerly operated at once, day or night, as a last resort, only to find that it was too late in more than one-third of the number, the mortality increasing with the time that had elapsed since the beginning of the attack.

In this class there is now a recovery of over ninety per cent., and if all cases of acute gangrenous and perforative appendicitis are counted, of over ninety-eight per cent., if the principles laid down above be thoroughly applied.

If peristalsis is inhibited, as it can usually be, the infection will become circumscribed and the pus can be evacuated with safety. Moreover, the condition we have just described is in itself the result of the administration of food and cathartics. Had these patients received neither food nor cathartics from the beginning of their attack, the affair would never have advanced to this dangerous point. This refers particularly to a class which Richardson has so well described as being "too late for an early, and too early for a late, operation."

Favorable changes that occur. If the plan we have outlined above is carried out the following changes are quite certain to occur: The nausea and vomiting will cease after one or two, or at most three, gastric irrigations. The meteorism and the pain will decrease greatly during the first twelve hours and will almost completely disappear in twenty-four hours. The pulse will become slower and firmer and more regular; the breathing deeper and the patient's general appearance will improve to an astonishing extent. The temperature will go below 100° F. the first twenty-four hours, and in three days it will be practically normal. The abdominal muscles will become soft as soon as the stomach contents have been removed by gastric lavage.

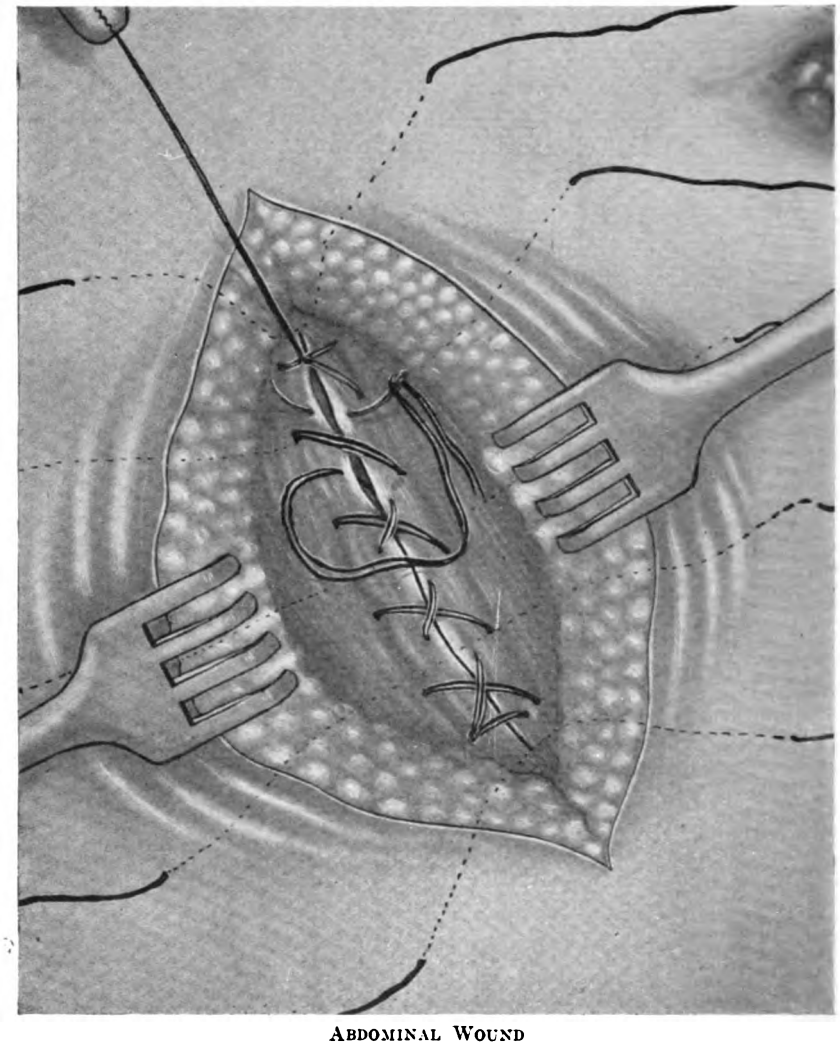
Usually the improvement is so rapid that one is tempted to spoil everything by giving nourishment by mouth, because the patient's condition does not seem serious enough to warrant such severe deprivation measures.

That this form of treatment—which we have employed since 1892, at first only in selected cases and later more and more generally—is really of great value is shown by clinical results. Our mortality in cases of perforative or gangrenous appendicitis with beginning diffuse peritonitis is less than one-fourth as high as it was in the cases operated at once upon making the diagnosis, and even in advanced cases of diffuse peritonitis there has been a marked decrease in the mortality in our experience.

It might be said that these cases were not due to perforative or gangrenous appendicitis, but that they were simply severe catarrhal cases, which are known to result favorably under any form of treatment. To this we would respond that we have later removed the appendix in many of these cases and have almost invariably demonstrated the correctness of the diagnosis.

Gastric lavage imperative. It might seem impossible, returning to our clinical case, to remove more substance from the stomach after she has vomited so frequently for a period of more than two days. Frequently physicians have considered this step superfluous, because they have imagined that the stomach must surely be empty under these conditions. This is, however, a very serious error. The fact that the patient is suffering from nausea or vomiting is the strongest indication for the use of gastric lavage, because the nausea is caused by the presence of decomposing material in the stomach and its removal must result in the greatest benefit. It frequently happens that these patients lose their anxious expression and restlessness, and that the skin becomes warm and moist and they begin to sleep directly after the gastric lavage has been practised.

Were a person in perfect health to place in his stomach the amount of decomposing food and mucus which we have just washed out of the child's stomach, he would at once become violently ill, and consequently the effect of this substance upon a patient whose strength has been exhausted by a severe acute illness must certainly be still worse. It is possible that there may be more material of the same character in the small intestines, but if so it will soon regurgitate into the stomach and make its presence known by the recurrence of nausea. Should this occur the gastric lavage should be repeated at once. If no food is given by mouth we have never been compelled to irrigate the stomach more than three times in the same patient, and usually one careful, thorough irrigation will suffice.



ABDOMINAL WOUND

Represents a further step in the closure of McBurney's incision, the fascia of the internal oblique abdominal muscle having been united with a continuous catgut suture.

Technique of lavage. It will be wise to direct attention to the method employed in such cases. The patient is turned upon the right side in order to add the weight of the intestines to the support of any adhesions which may

exist in the vicinity of the appendix. The head and shoulders are slightly elevated by means of pillows or a head-rest, or by elevating the head of the bed from thirty to fifty cm., then the pharynx is sprayed with a four per cent. solution of cocain in order to prevent gagging when the stomach tube is passed, because this might disturb the adhesions in the vicinity of the appendix. It is well to spray the pharynx repeatedly for a period of about five minutes, permitting the patient to swallow a little of the saliva mixed with cocain in order to anesthetize the esophagus to some extent at the same time. Not more than one teaspoonful of the cocain solution should be placed in the atomizer, in order to avoid harm from cocain poisoning. After holding the cocain in the pharynx a minute it is expectorated with the saliva which has accumulated and a fresh spray is applied. As most of the cocain is thus thrown out there is no danger from poisoning. After about five minutes a fairly large stomach tube is inserted and the contents of the stomach siphoned out. The stomach tube should have one or two lateral openings aside from the opening at its end. These openings should be within one to two inches from the end which is inserted in the stomach. This will prevent the end of the tube from becoming closed by drawing into it a portion of the mucous lining of the stomach.

Whenever there is any interruption in the flow this may be overcome by pouring a little water into the tube and thus dislodging any substance which may have become fixed therein.

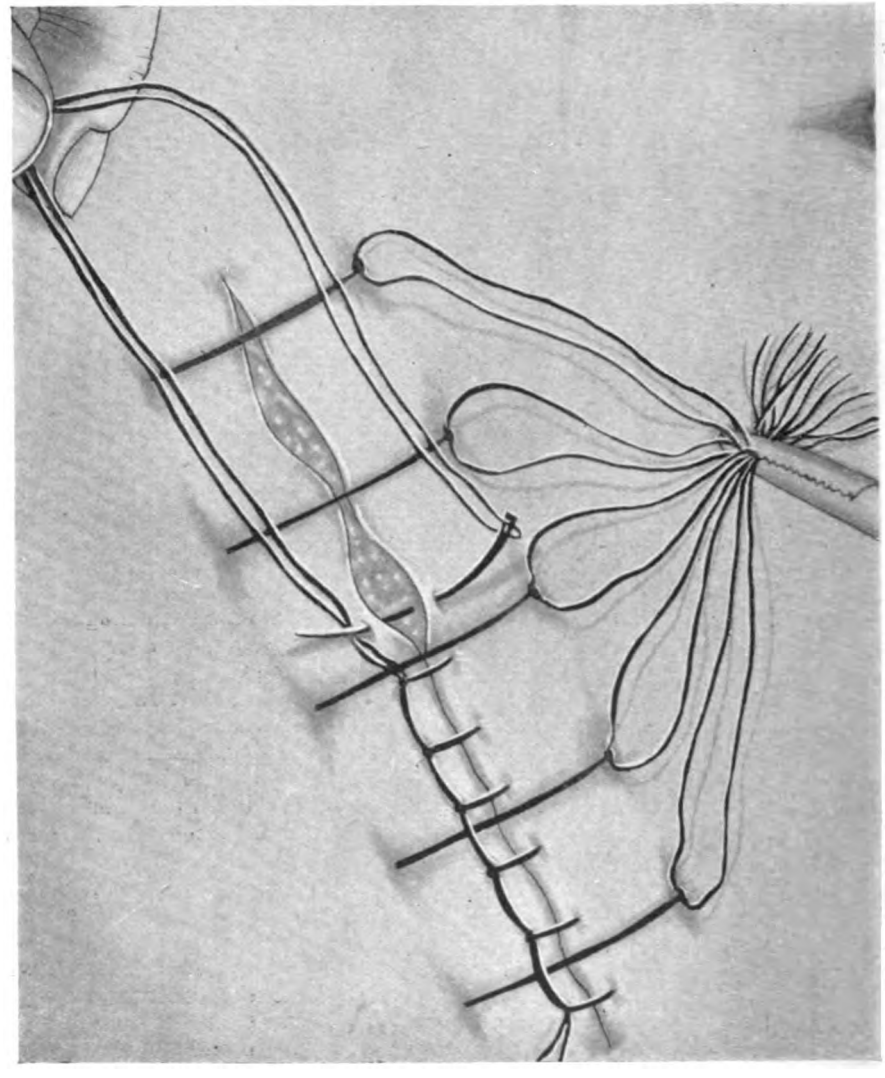
After the accumulation which was present in the stomach has been siphoned out it is well to introduce into the stomach a pint of normal salt solution at 100° F. and then siphon it out. This may be repeated until the fluid returns clear. It is well in these cases to elevate the foot of the bed about thirty inches just before withdrawing the stomach tube, after completing gastric lavage, and then to withdraw the tube slowly. In this manner it is possible to leave the stomach completely empty.

Continuous stomach drainage. A method of permanent drainage of the stomach, in cases in which there is regurgitation of intestinal contents into the stomach, has been introduced by Grosser. This consists in passing a small-sized stomach-tube into the stomach through one nostril and leaving it in place until no further accumulation takes place. In this manner the irritation and discomfort due to the repeated introduction of the stomach-tube can be avoided and the patient will obtain instant relief the moment any substance is regurgitated into the stomach without being subjected to the harmful effect of absorption of a portion of this offensive material, which occurs in the intervals between successive gastric lavages.

The quantity of fluid lost in this manner is restored to the patient by continuous but very slow administration of normal salt solution, or 4 per cent. dextrose solution by hypodermoclysis.

The Fowler position. The patient should now be placed in bed with shoulders somewhat elevated so as to favor gravitation toward the pelvis. The position introduced by Fowler, which is accomplished by elevating the head of the bed twenty-four to thirty inches, seems to be very useful in these cases, and we have practised placing our patients in this position constantly since Fowler demonstrated its value. She should receive absolutely no food and no catharties by mouth. Every four hours she should have an enema of an ounce of one of the concentrated predigested foods dissolved in three ounces of normal salt solution. We are confident that she will not require any anodyne, her pain will disappear spontaneously, since we have removed the cause of irritation by performing gastric lavage. It is, however, perfectly safe after performing gastric lavage to give the patient from ten to thirty drops of deodorized tincture of opium in each rectal feeding until the pain has completely subsided, should it persist after the gastric lavage has been com-

pleted. This would, of course, be extremely harmful were any food or cathartics to be given. In the meantime we will observe the patient carefully, because it is quite possible that circumscribed abscess may develop in the right inguinal region. If this should occur we will simply drain the abscess. It is surprising to observe how much infection will be disposed of by the peritoneum and the omentum, and how extensive an infection of the peritoneum



CLOSURE OF ABDOMINAL WOUND.

Represents the last step in the closure of McBurney's incision, the deep silkworm gut sutures and the coaptation sutures for the skin having been applied.

will subside completely, if one will only secure a condition of rest to the small intestines and thus prevent the further infection of the portions of peritoneum away from the point of primary infection in the vicinity of the vermiform appendix.

Exceptionally unfavorable cases. There are two classes of patients in whom this form of treatment is not so satisfactory as it is in all others, namely,

the very old and the very young. Very old patients do not bear confinement in bed well, no matter what their condition may be, and they do not prosper generally on rectal feeding. In these cases one is compelled to choose between two evils, and whichever is chosen one usually wishes it had been the other.

It should be stated here that very old patients bear confinement in bed much better when kept in the Fowler position than in the horizontal position, and since the introduction of this feature we have never had a case of hypostatic pneumonia in one of these aged patients because of their confinement to bed.

In children it is difficult to perform gastric lavage; they are likely to struggle and injure themselves while this is being accomplished. The same is true of administering rectal feeding. Moreover, the omentum in small children is not sufficiently developed to act as an efficient protection. It is consequently wise in these two classes, to operate whenever the patient's condition indicates that he will probably recover from the operation.

Return to diet. After the patient has recovered from the acute attack, which can be determined from finding the temperature and pulse normal, the diminished rigidity of the abdominal wall, pain and tenderness upon pressure absent, the obstruction to the passage of gas and feces relieved, feeding by mouth may be commenced gradually. It is well to give a small cup of beef tea made from some of the commercial beef extracts every three hours at first, because this will serve to encourage the patient, while it will not give rise to peristaltic motion as it is absorbed from the stomach, being composed almost entirely of non-irritating soluble substance. Later milk and lime-water, soups, broths and gruels may be allowed. We believe that it is well not to operate in these cases, after they have recovered from the acute attack, until they are in a condition in which it seems perfectly safe to give the ordinary dose of castor oil, which we are in the habit of administering in preparing patients for abdominal operations. Of course this should not be given as long as there is any doubt regarding the complete recovery, because if given too early it might be the cause of recurrence. If the oil causes no disturbance it is fair to suppose that the patient has fully recovered from the acute attack and is in a favorable condition for obtaining radical relief.

Many patients refuse to be operated after they have recovered from the acute attack, and until the past few years we frequently had patients come under our care on the third to the seventh day of an attack of acute perforative or gangrenous appendicitis whom we would treat through the acute attack with the method just described, but who would refuse operation during the interval. Later a number of these patients had recurrent attacks and were treated with catharties or were operated during the third or fourth day of a severe acute attack and thus lost their lives unnecessarily.

Later appendectomy. To avoid this we have followed the plan of confining these patients to liquid diet until the appendix has been removed, even if this is postponed for several months. If they change to solid food they usually experience some discomfort, and fearing another acute attack, have returned for operation and in time to have an interval operation.

We have many times made the error of operating too soon after an acute attack, but never has the interval been too long in cases in which the patient took nothing but liquids, together with soft boiled eggs, mush, purees, custards, boiled rice and thoroughly cooked cereals after recovering from the acute attack until the interval operation had been performed.

Confirmatory testimony. Since the publication of the last edition of this book, thousands of practitioners of medicine and surgery, and many distinguished surgeons who were not convinced of the correctness of our views concerning this subject at that time, have thoroughly tested the method and have

either privately or publicly stated that by adding this plan to their former conception of the indications for treatment of this disease, they have succeeded in reducing their mortality to a very marked extent.

Our own experience has still further confirmed the correctness of the views expressed in the former editions. Circumstances have been such that we have had an opportunity to demonstrate an enormous number of these cases to many surgeons from all parts of this and other countries, so that at the present time we need but repeat the indications expressed on this subject in the former editions, viz.:

Conclusions: In order that our views concerning the treatment of appendicitis may be perfectly understood, we here repeat the conclusions which were formulated some time ago and which have been followed throughout in the treatment of all of our cases.

1. The mortality in appendicitis results from the extension of infection from the appendix to the peritoneum, or from metastatic infection from the same source.
2. This extension may be prevented by removing the appendix while the infectious material is still confined to that organ.
3. The distribution or extension of the infection is accomplished by the peristaltic action of the small intestines.
4. It is also accomplished by operation after the infection material has extended beyond the appendix and before it has become circumscribed.
5. Peristalsis of the small intestine can be inhibited by prohibiting the use of every form of nourishment and cathartic by mouth and by employing gastric lavage in order to remove any food substances or mucus from the stomach.
6. The patient can be safely nourished during the necessary period of time by means of nutrient enemata. Large enemata should never be given, for they may cause the rupture of an abscess into the peritoneal cavity.
7. In case neither food nor cathartics are given from the beginning of the attack of acute appendicitis, and gastric lavage is employed, the mortality is reduced to an extremely low percentage.
8. In cases which have received some form of food and cathartics during the early portion of the attack, and are consequently suffering from a beginning diffuse peritonitis when they come under treatment, the mortality will still be less than two per cent. if peristalsis is inhibited by gastric lavage and the absolute prohibition of all forms of nourishment and cathartics by mouth.
9. In this manner very dangerous cases of acute appendicitis may be changed into relatively harmless ones of chronic appendicitis.
10. In our personal experience no case of acute appendicitis has died in which absolutely no food of any kind and no cathartic were given by mouth from the beginning of the attack.
11. The mortality following operations for chronic appendicitis is exceedingly low.
12. Were peristalsis inhibited in every case of acute appendicitis by the methods described above, absolute prohibition of food and cathartics by mouth and the use of gastric lavage, appendectomy during any period of the attack could be accomplished with much greater ease to the operator and correspondingly greater safety to the patient.

To reduce the mortality from appendicitis. The following suggestions for the treatment of appendicitis are made with a view of reducing the mortality:

1. Patients suffering from chronic recurrent appendicitis should be operated on during the interval.
2. Patients suffering from acute appendicitis should be operated on as soon as the diagnosis is made, provided they come under treatment while

the infectious material is still confined to the appendix, and if a competent surgeon is available.

3. Aside from insuring a low mortality this will prevent all serious complications.

4. In all cases of acute appendicitis, and in all cases of peritonitis, without regard to the treatment contemplated, the administration of food and cathartics by mouth should be absolutely prohibited and large enemata should never be given.

5. In case of nausea or vomiting, or gaseous distension of the abdomen, gastric lavage should be employed.

6. In cases coming under treatment after the infection has extended beyond the tissues of the appendix, especially in the presence of beginning diffuse peritonitis, conclusions four (4) and five (5) should always be employed until the patient's condition makes operative interference safe.

7. In case no operation is performed neither nourishment nor cathartics should be given by mouth until the patient has been free from pain and otherwise normal for at least four days.

8. During the beginning of this treatment not even water should be given by mouth, the thirst being quenched by rinsing the mouth with cold water and by the use of small enemata. Later small sips of very hot water frequently repeated may be allowed, and still later small sips of cold water. There is danger in giving water too freely, and there is great danger in the use of large enemata.

9. All of these cases are greatly benefited by the use of continuous normal salt solution by rectum, given according to Murphy's directions.

10. All practitioners of medicine and surgery, as well as the general public, should be impressed with the importance of prohibiting the use of cathartics and food by mouth, as well as the use of large enemata, in cases suffering from acute appendicitis or peritonitis.

11. It should be constantly borne in mind that even the slightest amount of liquid food of any kind by mouth may give rise to dangerous peristalsis and may change a harmless, circumscribed into a dangerous, diffuse peritonitis.

12. The most convenient form of rectal feeding consists in the use of one ounce of any of the various concentrated liquid predigested foods in the market, dissolved in three ounces of warm normal salt solution, introduced slowly through a soft catheter, inserted into the rectum a distance of two or three inches.

13. This form of treatment cannot supplant the operative treatment of acute appendicitis, but it can and should be used to reduce the mortality by changing the class of cases in which the mortality is greatest into another class in which the mortality is very small after operation.

14. It is important to bear in mind the fact that this treatment is always indicated without regard to whether an immediate operation is or is not contemplated.

15. It is further important not to be deceived by the very rapid improvement of what appear to be serious cases into the belief that the case is not a gangrenous or perforative appendicitis, because such patients may easily be killed by giving food too early.

Diagnosis. In order to treat patients suffering from appendicitis with the greatest degree of success, it is important to make a careful, early diagnosis. This will depend upon two conditions:

A careful physical examination. This should be made in every case in which there is any symptom of intra-abdominal disturbance. It has been our experience to find a mistaken diagnosis at the beginning of an attack of appendicitis has usually resulted from the fact that the family physician, when first

called, was willing to make a diagnosis of gastritis, or enteritis, or catarrhal disturbance of the alimentary canal, from the symptoms given by the patient or his friends, without himself making a physical examination in order to ascertain the actual state of affairs. This is true even more commonly in children than in adults. Until very recently more than ninety per cent. of all cases of appendicitis in children came into our hospital service with a diagnosis of gastritis, and more than fifty per cent. had not been subjected to a physical examination.

Only a few years ago more than fifty per cent. of all women entering the hospital suffering from appendicitis came with a diagnosis of tubal infection. This error was so common at that time that many of the best authors upon this subject of appendicitis stated that the disease occurred much more frequently in men than in women. (Deaver, Fowler, Mynter, etc.)

A careful physical examination will, of course, usually eliminate these errors, and will enable the physician to prevent the patient from doing things which must certainly increase the gravity of the disease, and which undoubtedly are frequently responsible for the fact that the correct diagnosis is not made until the patient is almost or quite in a hopeless condition. We would consequently insist upon making a careful physical examination in every patient the first and most important step toward securing proper treatment in cases of appendicitis.

Clinical experience. Nothing serves so well to aid a physician in comprehending proper treatment of these cases as the observation of some of the various forms of appendicitis throughout their course, and especially through the necessary operation. This is true particularly of physicians practising internal medicine. One can really not have a clear idea of the behavior of a diseased appendix unless he has observed it in all stages of disease in the living human body. It is such a natural matter to imagine, when the acute condition subsides, that the amount of disturbance must have been slight, that unless one has an opportunity later to demonstrate the actual condition by removing the appendix he is not likely to appreciate the gravity of the disease in ordinary acute cases.

On the other hand, unless one has observed the intra-abdominal condition during the acute attack in some of the most desperate cases of acute perforative or gangrenous appendicitis, in which the removal of the organ seemed impossible even in the hands of the most skillful surgeon, and a year or more subsequently at a second operation the almost normal condition of everything within the abdominal cavity, with the exception of the appendix itself and possibly a few unimportant adhesions, he is hardly competent to appreciate what Nature can accomplish within the peritoneal cavity.

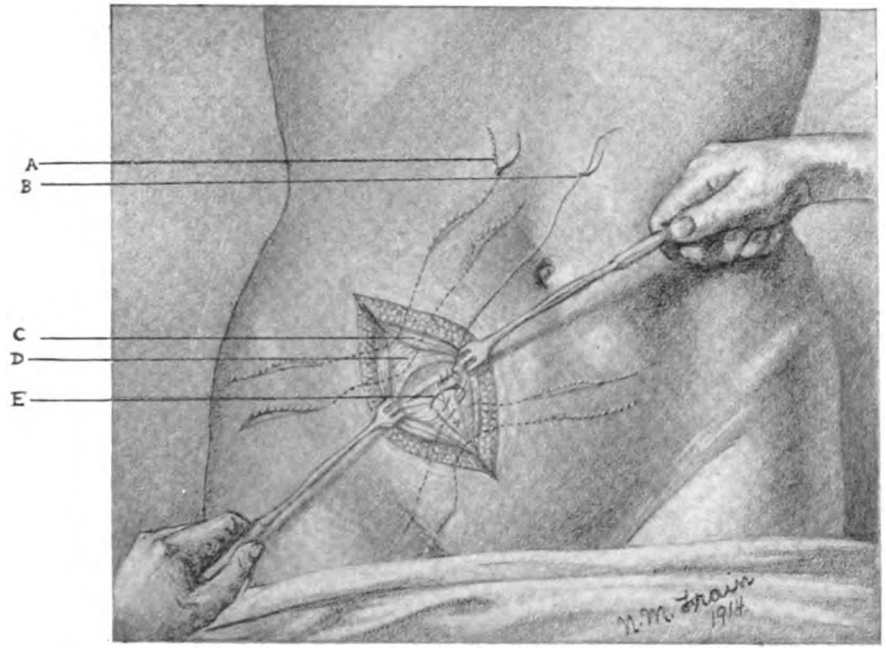
In order to become familiar with these pathological conditions we believe the student of medicine and the practitioner doing post-graduate work should observe these cases before, during and after operation in the great hospitals where such examples are numerous, and they should study the pathological condition in the living patient. In the study of these processes in the living patient one is impressed with certain facts which it is believed have a very important bearing upon the treatment of appendicitis.

Drainage of the appendix. So long as the appendix is in a condition in which its lumen is thoroughly drained the organ will not cause any serious trouble, and just in the proportion in which this drainage is interfered with will the danger to the patient increase.

Primarily, the obstruction is always due to an inflammation, either directly because of the accompanying congestion or edema, which in itself may suffice to obstruct the cecal end of the lumen; or it may be that the first infection subsides and leaves a small ulcer which heals and causes a slight amount of

contraction, and at the time of the next acute congestion or inflammation this portion of the lumen is already abnormally small and consequently the more easily obstructed.

The moment this portion of the lumen becomes completely obstructed a sudden increase in the infection is certain to occur, and this will constitute a real danger to the patient. Again, in many cases the appendix contains infected granulation tissue for a considerable period of time, which will be in a condition to at any time cause an obstruction of the lumen of the appendix and thus be favorable to the production of serious trouble.



McBURNEY INCISION WITH LATERAL EXTENSION.

This illustrates a case in which the typical McBurney incision failed to give sufficient space to safely remove an adherent appendix and in order to secure the desired space a second incision was made through the internal oblique abdominal muscle, transversalis fascia and peritoneum. A, shows deep silkworm gut suture; B, suture for peritoneum and transversalis fascia; C, aponeurosis of external oblique abdominis muscle; D, internal oblique abdominis muscle; E, suture uniting the cut ends of the internal oblique abdominis muscle.

Whenever an infection approaches the surface of the appendix the latter is likely to become adherent to the surrounding tissues, and this in turn results in an obstruction to the lumen of the appendix by causing short bends or kinks. At any given time this obstruction may become so complete that nothing will drain into the intestine, and then there is grave danger of gangrene of the organ from pressure as well as from interference with the circulation. There is the same difference between an infected appendix with free drainage into the cecum, and one in which this drainage has been obliterated, that we find in an acute abscess in any other portion of the body that is thoroughly drained and one in which no drainage has been established.

The increased pressure upon the tissues surrounding an abscess in any portion of the body will sooner or later produce pressure-necrosis, and this prob-

ably accounts for gangrene of the mucous lining of severely distended appendices so frequently met with in relatively early operation in severe cases of acute appendicitis.

Condition of the appendix after an acute attack. It seems most important to impress the clinical fact upon our minds that whatever the changes may be which occur in any given case as a result of acute or chronic inflammation of the appendix, the latter is rarely in as favorable a condition as regards the safety of its possessor after as before the occurrence of this inflammation. The change in its structure is almost invariably a reduction of some portion of its lumen, and this necessarily means a certain degree of interference with its drainage, and this in turn produces a tendency to the recurrence of an acute or chronic inflammation.

There are but two conditions in which the above course does not obtain: First, in the rare case in which a patient recovers from an acute attack in which the appendix is entirely destroyed, and, second, where the obliteration of the lumen begins at the distal end of the organ and progresses uniformly toward the cecal end. This is also exceedingly rare.

All of these results are impressed upon the surgeon more and more forcibly as his experience increases, and it seems as though their observation should lead to methods of treatment which would be more and more favorable to the patient.

There can be no doubt but that in a vast majority of cases a vermiform appendix which has once been the seat of severe inflammatory disturbance can never thereafter be perfectly normal.

At best, the normal appendix contains conditions very favorable for inflammatory disturbances from the fact that it is a blind, dependent sac with its open end communicating with the cecum, which normally always contains septic material.

Localization of the disease. While so much can be said against this organ, yet the more one comes in contact with it the more points will he find which seem favorable to the patient who possesses a diseased appendix if the latter is removed while the infection is still confined to its lumen. First, there is, with the exception of a few very rare instances, always a time in every case of appendicitis when all of the infectious material is confined to this organ and under conditions which are favorable to removal without appreciable interference with any other organ. Second, the appendix is in an accessible region. Third, it is easily located by following the longitudinal band upon the surface of the cecum in a downward direction until it is found. Fourth, its removal from the cecum is extremely simple and when once removed the cecum can be left smooth and without any denuded surfaces. In other words, after the appendix has been removed the patient is in no way physically impaired. This, however, is true only so long as the infection is still confined to the appendix itself, a condition which exists during the very beginning of an acute attack, and after a patient has perfectly recovered from an acute attack. This being the case, it seems logical to conclude that if a patient comes under care during a time when he is in this condition, it will be proper to relieve him of this useless and dangerous organ.

Time limit of local infection. In acute appendicitis no definite time can be given during which the infection is probably still within the appendix itself, but in severe cases this may usually be accepted as during the first thirty-six hours after the beginning of an attack. In mild cases this condition often obtains throughout the entire period of the acute attack. It is consequently important to use one's judgment, rather than to go by any number of hours, in determining whether the infection is still within the appendix.

It is quite important, however, to determine this fact, because if one can be

certain thereof he can also be certain that with a reasonable amount of skill and experience in abdominal surgery all of the infectious material may be removed from the peritoneal cavity at once, leaving the latter in an exceedingly favorable condition for a speedy and permanent recovery.

The determining condition of the immediate operation. All surgeons with extensive experience in the treatment of appendicitis at the present time seem to agree upon this one view: *That in acute appendicitis, in which the patient comes under the care of the surgeon during a time when the infection is still confined to the appendix, an immediate operation is indicated, provided a competent surgeon is available and the other conditions necessary for the successful execution of abdominal operations are within reach.*

This is true for the following reasons:

1. The patient is practically certain to recover.
2. He will be able to resume his occupation within a short time.
3. He cannot have a recurrence.
4. It practically eliminates complications, such as adhesions, metastatic abscesses, empyema, septic endocarditis, thrombo-phlebitis and peritonitis.
5. Drainage will be unnecessary, hence there is no danger of post-operative ventral hernia.
6. The infection of the pelvic organs in the female, with their serious consequences, as adhesions, dysmenorrhea, sterility, ovarian cyst, etc., will be avoided.
7. There will not be the serious digestive disturbances which are practically always present in patients suffering from recurrent appendicitis.
8. The amount of suffering will be reduced to a minimum.

Another reason which is commonly mentioned and which is not infrequently given in favor of an immediate operation, not only in this class of cases, but in all suffering from acute appendicitis, is the fact that we are supposed not to know what will be the outcome in any given case of appendicitis. This, however, is true only in cases in which the treatment before they come under care has been improper, and in which the future treatment is likely to be equally bad.

In any given case in which the treatment from the first has been proper, and in which it will be equally good in the future, we can predict with as much certainty as in any disease that we are called upon to treat just what the future will bring. This is true because of the peculiar position of the appendix and because of its environment.

The appendix is located in a secluded portion of the peritoneal cavity and it is surrounded, with the exception of the inner side, by relatively fixed structures. About it we find in front, the cecum; to the outer side and behind, the abdominal wall; below, the pelvic cavity; and only to the inner side have we the exceedingly movable small intestines. Aside from this we have the omentum, which is always ready to care for a diseased appendix by placing its folds about the later and preventing septic material from infecting any of the surrounding structures.

Nature's protective influences. Our observations have been convincing beyond a doubt that the tendency of Nature is to maintain a condition of rest, and thus to confine the infection to this secluded portion of the peritoneum. Our evidence for this conclusion lies in the following facts:

1. The ileo-cecal valve at once prevents the passage of gas and feces.
2. The nausea and vomiting results in the expulsion of at least a portion of the offending intestinal contents.
3. All of the available omentum collects about the appendix.
4. The contraction of the abdominal muscles over the appendix limits motion in this portion of the abdominal cavity.

5. The right thigh is frequently flexed to enable the contraction of the iliacus muscle behind the appendix.

6. Whenever the abdomen is opened in cases in which peristalsis has been inhibited early in the attack by making gastric lavage and then giving neither food nor cathartics by mouth, the appendix is found virtually surrounded by parietal peritoneum, cecum, cecal end of ileum and omentum, and thus it is prevented from causing trouble, even though it be gangrenous or perforated. Moreover, we have observed that when Nature is aided in carrying out this tendency to establish a condition of rest, it will result either in the absorption of any infectious material which may have advanced beyond the tissues of the appendix; or, if this be no longer possible, it will result in the formation of a relatively harmless, circumscribed abscess, which, if this condition of rest is maintained, will practically always either perforate into the cecum, or point toward the anterior abdominal wall where it may be drained easily and safely, or it will rupture into the rectum.

There are a few exceptions to this rule which should be mentioned here. In very emaciated patients with almost no omentum, and in young children in whom the omentum is often very slight, this organ occasionally fails to supply the necessary protection.

It should be stated at this point that circumstances have made it possible for us to observe an unusually large number of cases of appendicitis, which we have been able to follow through the acute attack and later been able to demonstrate the pathological conditions by removing the part. We should also state that in every case in which it was possible to obtain the consent of the patient we have removed the diseased appendix either during an acute attack, provided the patient's condition seemed to indicate that the operation could be performed safely; or if this was not the case, to remove it in the interval at the conclusion of the acute attack.

Review of an extensive series of cases. During the past few years since the publication of the following statistics our results have improved very greatly for several reasons. 1. Our experience has been vastly increased and with this our judgment has improved in determining the conditions which in turn served as indications to details in treatment. 2. Practitioners in general do not at the present time give cathartics and food by mouth in these cases as they did formerly when almost every patient admitted to the hospital had previously received both cathartics and food by mouth. 3. We admit many more patients within the first forty-eight hours after the beginning of the attack. 4. Our operative technic has undoubtedly improved with these added years of experience. 5. The method of giving normal salt solution by rectum by the drop method has been of enormous value.

Instead of giving the newer statistics it has, however, seemed wise to repeat those of the period when our methods were on probation because the lessons from the blunders made during this period seem especially valuable.

In preparing the preceding editions of this work it seemed proper to make a general review of our clinical experiences in the treatment of appendicitis in the interval, because our position concerning this subject at the time the first edition appeared did not correspond with that held by other authors at that time.

In order to substantiate the opinion expressed in the first edition of this volume, we have reviewed all the histories of one thousand consecutive cases of appendicitis, which we operated at the Augustana Hospital during the thirty-three months from July 1, 1901, to April 1, 1904. During this period of time every patient suffering from appendicitis was admitted, at any time of day or night, without regard to condition, several of them dying almost immediately upon admission, and all such cases are included in these statistics.

Of the cases that were not operated only those who died were counted in this series of one thousand, because in those who recovered from the acute attack, but were not operated, it was impossible to determine the exact anatomical diagnosis.

On the other hand, it was necessary to count the cases that died, but were not operated, seven in all, because the statistics would otherwise not be fair in comparison with those of other surgeons, who might have operated these fatal cases. We would say, however, that with possibly one or two exceptions these seven cases were quite beyond hope when they entered the hospital.

The number, one thousand, was chosen because of the convenience with which one can grasp statistics based upon multiples of ten. They were all taken from the Augustana Hospital records, because we have all of the cases at this institution under personal observation every day; while those operated at other hospitals we can observe less constantly.

CLASSIFICATION

	Cases.	Mortality. Deaths.	Mortality. Percentage.
Chronic appendicitis or interval operations	540	3	.5
Acute appendicitis without perforation	255	5	1.9
(Of these six entered the hospital within thirty six hours after beginning of attack.)			
Acute appendicitis, perforated or gangrenous, without abscesses	55	0	.0
(Of these five entered the hospital within forty-eight hours after beginning of attack.)			
Acute appendicitis, perforated with abscess	117	4	3.4
Acute appendicitis with diffuse peritonitis	33	10	30.0
Total	1,000	22	2.2

Of the 255 acute appendicitis cases without perforation 200 were operated upon entering the hospital and 55 were treated by gastric lavage and absolute prohibition of food and cathartics of every kind by mouth, the nutrition being accomplished by means of small enemata. Of this class only six cases entered the hospital within thirty-six hours from the beginning of the attack.

There were 55 cases in which there was a gangrenous or perforated appendix, which were admitted before an abscess had formed. Of these there were five who entered within forty-eight hours after the beginning of the attack. Of the entire number 21 were operated at once and 34 were first starved until they seemed in a safe condition for operation. In most of these cases the appendix was completely surrounded by the omentum and held away from all other intra-abdominal structures.

Of the 117 cases of acute appendicitis, perforative or gangrenous, in which an abscess had formed, 39 were operated at once and 78 were treated by prohibition of all nourishment and cathartics by mouth until their condition seemed sufficiently improved to make the operation appear safe.

Of the 33 cases entering with diffuse peritonitis resulting from perforative or gangrenous appendicitis, all were treated at first with gastric lavage and exclusive rectal feeding. Of this class a number should not have been admitted, because they were in a dying condition when they arrived at the hospital, but for fear of excluding any case which might recover, notwithstanding its apparently hopeless condition, we have made it a rule never to refuse a patient suffering from any acute non-contagious disease. This will account for what

we believe is at the present time rather too high a mortality in diffuse peritonitis due to perforative or gangrenous appendicitis.

Among the 33 cases belonging to this class there were seven which were not operated, because they were in a dying condition when they entered the hospital, or because from the time of admission to the time of death their condition was always such that, with previous experience with similar cases, operations had always terminated fatally. Still these cases were counted among our deaths, in order to include the entire mortality of all the cases treated.

It is plain that if these cases were eliminated and the cases added in which recovery followed non-operative treatment, our percentage of mortality would be reduced. We would thus have only 15 cases in more than 1,000, but this would not be absolutely fair, because it might be argued that the death in at least some of these seven cases should be attributed to an error in judgment, and that if even the apparently absolutely hopeless cases had been operated at once some of them might have recovered.

Five hundred and forty cases of chronic appendicitis: Three deaths. In reviewing the histories of these cases we find many interesting facts.

Case 1. Among the three deaths in five hundred and forty cases of chronic appendicitis with interval operations, we find that one case, a weakly, unmarried woman, twenty-seven years of age, who had been ill much of the time during her entire life, had an acute attack of appendicitis two years before entering the hospital, and a second attack one year before, since which time she had never been free from pain. At time of operation the appendix was found adherent, 13 cm. long, cicatricial at distal end, partially obstructed at cecal end, containing a small amount of pus, pelvis secondarily infected, uterus retroverted and adherent, together with ovaries and tubes, in pelvis. Tubes closed at distal end containing small amount of pus, removed, round ligaments shortened. No drainage.

Patient died four weeks after operation from exhaustion, probably due to absorption from raw surface in pelvis. Had this case been drained she would probably have recovered. This is undoubtedly also true if only the appendix had been removed. This was without doubt the offending organ, and it is believed that its removal would have resulted in a fair recovery, because the pelvic organs when secondarily infected usually show great recuperative powers after the obstructed, infected appendix has been removed.

Case 2. A married woman, thirty-six years of age, having suffered from puerperal infection after the births of two children, thirteen and fourteen years ago, each time lasting six weeks; had severe attack of acute appendicitis twelve and a half years ago, confining her to bed for three weeks. Since that time she has constantly suffered from subacute appendicitis.

At the time of the operation patient was in a greatly reduced condition. The appendix was club-shaped at distal end and almost completely occluded at cecal end, and contained several hard, fecal concretions. This was removed and also both tubes and ovaries, which were adherent in the pelvis, probably as a result of the puerperal infection. No drainage was established. The patient died on the fifteenth day after the operation from exhaustion. The same error in treatment accounted for the death of this patient as of the previous one.

In patients who have been greatly reduced by long-continued disease it is not wise to operate too extensively, and if this is done drainage should be used in order to relieve them of the burden resulting from the necessity of absorbing the secretion from denuded surfaces.

Case 3. In this patient, a woman thirty-four years of age, the chronic appendicitis existing for a period of nine years was complicated by double pyosalpinx. Both tubes, the right ovary and the appendix, were removed. The appendix was 18 cm. long, acutely flexed about its middle by an adhesion to the cecum. The distal end contained mucus and fecal matter.

The patient showed symptoms of intra-abdominal hemorrhage four hours after the operation. She was reopened hurriedly and it was found that the ligature upon the severely congested right broad ligament had cut through the ovarian artery and the patient succumbed to the loss of blood.

The husband of this patient was at the same time under treatment by a colleague for specific urethritis. It is consequently plain that the infection of the tubes was not due to the appendicitis.

This death was due to an avoidable accident.

The three deaths in this group would have been avoided had the operation been confined to the removal of the diseased appendix. The amount of disease found in the tubes seemed, however, at the time, to indicate their removal.

Ordinarily in similar statistics none of these cases would be included in deaths resulting from appendicitis operations, because the appendicitis operation had no relation to the deaths, but in these statistics every case is counted in which the appendix was removed during this period of time even though the other disease for which the patient was operated at the same time was by far the most serious condition.

Acute appendicitis without perforation: 255 cases, 5 deaths.

Case 1. Married woman, forty-eight years old, four pregnancies, two abortions. Has had many slight attacks of appendicitis during past five years, accompanied by severe pain, lasting from two to five hours. Last night had an attack more severe than any previous one. Suffered severe pain over region of appendix of a diffuse character when it commenced. Abdominal walls very thick, making palpation impossible. Operation at once, because it seemed likely that the infection would be found confined to the appendix. The appendix was found universally adherent behind the cecum, partly surrounded by the omentum. It was removed with difficulty, necessitating a considerable amount of manipulation of the cecum and the omentum. No drainage.

The patient died of peritonitis on the tenth day after the operation, probably due to the traumatism necessary in the removal of the deeply buried appendix, together with infection from the acutely inflamed organ.

Had this patient been starved during the acute attack and operated in the interval she would probably have recovered.

Case 2. This patient, an emaciated man forty-four years of age, entered the hospital at the end of an acute attack, which had not been very severe. He had suffered from recurrent attacks of appendicitis at various intervals for a period of about twenty years. The last three attacks had been more severe and he was unable to recuperate from them. Operated at once and found a severely congested appendix, club-shaped at the distal end and constricted at the cecal end. It was universally adherent to the lower end of the cecum and the distal end, which contained a small amount of pus, was adherent to the anterior surface of the iliacus muscle.

The appendix was dissected out and the wound closed. The patient died on the seventh day from peritonitis. The autopsy showed a small amount of cloudy fluid in the pelvis. The infection had started from the tissues to which the club-shaped end of the appendix had been adherent, having evidently extended through the walls of the appendix during the late acute attack. This death could have been avoided by proper drainage. It is to be charged to faulty technique.

Case 3. Is interesting because quite unusual. A strong laborer, twenty-four years of age, had an acute attack of appendicitis one month ago which lasted one week. Within two days there had been a slight recurrence, but it seemed likely that infection was confined to the appendix.

The operation showed a congested, edematous appendix coiled upon itself like a snail, adherent between the lower end of the cecum and the mesentery of the ileum, obstructed at its cecal end and containing pus and feces in its distal end. Abdomen closed without drainage.

On the third day after operation there developed a pneumonia, which progressed in a mild form until the patient suddenly contracted a pneumococcus peritonitis, of which he died on the seventeenth day after operation.

The anesthesia had been started with chloroform, which was changed to ether just before beginning to operate, and continued with ether throughout.

Pneumonia is much more likely to occur in cases wherein the alimentary canal has not been thoroughly emptied by a cathartic, hence it is likely that this patient would not have died had we waited to do an interval operation.

Case 4. A farmer, thirty-four years old, entered the hospital, giving a history of rather a severe acute attack of appendicitis one month previous, from which he had recovered in one week with the exception of marked tenderness and some pain over McBurney's point. His temperature was normal and his pulse sixty-six beats per minute. He was otherwise normal.

The appendix was universally adherent behind the cecum, was obstructed at the cecal end and contained bloody pus; it was nineteen centimeters long and its distal end reached nearly up to the liver. The denuded surface was covered with peritoneum and the abdomen closed without drainage. The patient died five days after the operation from acute peritonitis.

Drainage would have prevented this death. Dissecting out so long an appendix containing pus, before the acute attack had completely subsided, without instituting drainage, we think showed bad judgment.

Whenever there is the slightest doubt in any case about requiring drainage it should be the rule to drain. In other words, when absolutely certain that drainage is not needed, close without drainage; when in doubt at all, drain.

Case 5. A boy fifteen years of age became ill with typhoid fever eight weeks before, which lasted five weeks; was apparently well two weeks ago. Ten days ago developed slight

fever and was confined to bed for three days; then he was apparently well until ten hours before he was brought to the hospital, when he developed excruciating pains over the entire abdomen, which became more severe in the region of the appendix. When the family physician was called he found the boy writhing in pain lying upon the floor. He immediately sent him to the hospital with a diagnosis of probable perforation of typhoid ulcer, with a possible diagnosis of acute appendicitis.

The patient was at once anesthetized with chloroform, then ether was given throughout the operation, which lasted but twenty minutes. The appendix was found edematous, congested, the size of a finger. It was removed. Its walls were very thick, its lumen was occluded at the cecal end by the edematous mucous membrane; the mucous membrane of the appendix was gangrenous in a number of circumscribed spots one centimeter in diameter.

The patient had uremic convulsions almost at once upon recovering from the anesthetic, which became more and more frequent, notwithstanding the use of hot air baths and transfusion of normal salt solution. Just before he was anesthetized he had a slight convulsion, which was supposed to be the result of his severe suffering, but which was probably uremic.

In this case the indications for immediate operation were so strong that it is doubtful whether one could have improved upon the treatment, but this is the only case in the group of five that probably could not have been saved with proper care and even in this case, it may have been bad judgment to undertake operation so soon after his recovery from typhoid fever. Had we placed him on proctoclysis by the drop method and prohibited all nourishment by mouth, he would probably have recovered. In each one of the preceding four cases, the death was undoubtedly due to bad surgical judgment or bad technique.

Conclusions. All of these patients were operated immediately upon entering the hospital because their condition seemed to indicate that the infectious material was confined to the appendix. Had these five cases been added to the fifty-five of the group in which gastric lavage was employed, and which received neither food nor catharties by mouth, but were confined to exclusive rectal feedings, it is likely that three or possibly four might have recovered. This favorable outcome might also have been secured had drainage been instituted.

The total result of less than two per cent. mortality in this group of 255 cases of acute appendicitis is, of course, eminently satisfactory, but with the addition of the above criticism, it is believed that results in a corresponding group of the same number of similar cases we can look for a further reduction in the mortality. (This prediction was made more than twelve years ago and our experience since that time has proven the correctness of the statement. The mortality in these cases is now less than one per cent.)

Acute perforative or gangrenous appendicitis without abscess: 55 cases, no deaths. The next group is especially interesting, because it contains fifty-five cases in which the appendix was completely surrounded by omentum and in which this protection was so effective that, notwithstanding the presence of gangrene or perforation, the infectious material had remained perfectly circumscribed. In all of these patients, without regard to the contemplated treatment, food by the mouth and catharties were prohibited at once upon admission to the hospital, gastric lavage was employed, exclusive rectal feeding was instituted and continued for one week or longer, in fact until they were normal as regards temperature, pulse and pain in the region of the appendix. Five of these cases entered the hospital within forty-eight hours after the beginning of the attack and were operated at once. Sixteen of the remaining cases seemed in a condition making an immediate operation safe and were operated at once. The remaining thirty-four cases were placed upon exclusive rectal feeding until their meteorism, pain and temperature had disappeared and their general condition had improved to the point at which it seemed safe to perform the operation. This occurred in most cases within four days after admission, while in others the interval was longer.

In this group of cases there is much danger of supposing that a wrong diagnosis had been made primarily, and that it would be safe to give at least liquid food and possibly catharties as soon as the patient became apparently

normal. We are certain that this error has cost a number of lives and has been responsible for many serious recurrences.

The condition is not as rare as one might suppose, as 55 cases in a group of 1,000 makes 5.5 per cent.

Acute perforative or gangrenous appendicitis with peritonitis and abscess: 117 cases, 4 deaths. All of these patients entered the hospital after the third day from the beginning of the attack. They had all received some form of food before admission, and most of them had received cathartics.

Quite a proportion of these cases stated that they had received no food of any kind, but when questioned specifically as to whether they had not received either milk or broth or soup, every one that had previously affirmed that no food at all had been taken admitted that one or the other of these forms of nourishment had been given them.

Many of these patients were received in a desperate condition, with what seemed at first to be diffuse peritonitis, severe distension of the abdomen, which was perfectly tense, nausea and vomiting. The slightest jar of the bed would cause severe distress. Many of them had a bad facial expression and seemed to be in a condition of shock with cold perspiration over the forehead.

It is in this class of cases that we formerly had a large mortality, which is still shared by all surgeons who operate at once in every case of acute appendicitis immediately upon making the diagnosis.

These were classed by Mynter as beginning diffuse peritonitis. Personally we had considered them as belonging to a class in which the primary diagnosis of severe peritonitis was incorrect, as proven by the fact that the abscess later became circumscribed; but a study of the excellent work of Moszkowicz seems to prove beyond a doubt that the peritoneum in these cases has a sufficient amount of resistance to change an early diffuse into a late circumscribed peritonitis.

Absorption of poisonous intestinal products. One very important point has not received sufficient appreciation here—namely, that the very bad general condition of the patient is much exaggerated by the fact that a great amount of decomposing substance is being absorbed from the stomach and small intestines, which would in itself suffice to make an otherwise perfectly healthy person extremely ill.

The excellent studies of Maury have demonstrated that this view is absolutely correct; that there is indeed secreted from the lining of the duodenum in these cases an exceedingly poisonous substance, consequently the benefit which we had demonstrated empirically, has now been confirmed scientifically. These patients give one the impression of having been poisoned so long as the decomposing substance remains in the stomach.

In these cases the localized inflammation in the region of the appendix prevents the elimination of the contents of the stomach and the small intestines through the rectum, and thus decomposition is greatly increased, as there is no natural drainage. In most of them we have found that just enough food is placed in the stomach, suited for decomposition, to produce the worst possible conditions. It would be as reasonable to suppose that a person would not be in danger of drowning if he were submerged beneath but a small amount of water, as to suppose that small amounts of liquid nourishment given by mouth are harmless, when one fully comprehends existing influences.

This is still further favored by the foolish idea that there can be nothing left in the stomach because the patient has vomited incessantly for a number of hours. In many of the cases where vomiting had continued persistently for hours we have removed great quantities of decomposing material, in fact, apparently enough to hopelessly poison a healthy person.

Upon removing this material by gastric lavage we have seen many patients improve in a remarkable way. Frequently the temperature will become normal, or nearly so, within forty-eight hours, the pulse reduced from one hundred and twenty beats, or more, to one hundred, or less, per minute. The nausea and vomiting will disappear after one or two, or at most three, gastric lavages, the tympanitis will be greatly reduced, and not uncommonly it will be possible to outline a swelling in the region of the appendix.

Probably it will never be possible to treat this class of cases entirely without mortality, but with the method we have employed the mortality has been reduced to less than 3.5 per cent. (Since this was written our mortality in this class of cases has been reduced to less than two per cent.) The deaths in this class occurred in the following four cases:

Case 1. A well-nourished man, thirty-two years of age, with a good history, with the exception of some apparently unimportant digestive disturbances, which were, however, probably referable to a chronic appendicitis, entered the hospital on the fifth day of an acute attack. Patient received no food from the beginning of the attack and no cathartics during the first two days; on the third and fourth days some liquid food was given, and on the fourth day a dose of calomel was administered. Patient did very well during the first two days, suffered a little more during the third day and became violently ill twenty hours after the administration of calomel.

On admission temperature was 103 degrees F. and the pulse 94. He suffered severe pain in the right inguinal region, the abdomen was severely distended with gas and a mass could be palpated in the right inguinal region. The patient's facial expression was bad and it seemed as though the peristalsis caused by the administration of the calomel had produced an extension of the previously circumscribed peritonitis, but as there was evidently an abscess present, immediate operation was performed.

An incision twelve centimeters in length through the right rectus abdominis muscle evacuated nearly a litre of foul pus. The abscess was freely drained with two glass drainage tubes and with iodoform gauze, without making an attempt at removing the appendix. Death occurred three days later from peritonitis.

In this case it seems clear that the diffuse infection was due to the peristalsis caused by the administration of calomel on the fourth day of the attack. It may have been bad practice to operate at once, but at the time it seemed proper. This death must, of course, be charged to the murderous use of cathartics in acute appendicitis.

Case 2. A somewhat emaciated boy, fourteen years of age, entered the hospital on the twelfth day after the beginning of his attack. During the first six days the attack was mild and he received food by mouth. During the last six days he had received only a small amount of liquid nourishment by mouth. Temperature, 102 2 degrees F. Pulse, 100. Patient appeared very weak and ill, his abdomen was distended with gas. For the first five days after admission exclusive rectal feeding was employed and the infection became circumscribed in the right iliac region, reaching a little beyond the median line to the left. An incision ten centimeters long was made through the right rectus abdominis muscle. The appendix was found perforated at the distal end. It was surrounded by the cecum, the ileum and the omentum. The perforation in the end communicated with an abscess containing several ounces of pus, which was carefully evacuated by sponging, then the appendix separated from its adhesions and removed, which in this case was undoubtedly the fatal mistake. The abscess cavity was drained. The patient died of peritonitis two days later.

Had we used better judgment in this case by simply draining the abscess and removing the appendix later on in the interval, the patient would probably have recovered.

The additional time consumed, the increased trauma and the exposure of abraded surfaces in a patient with slight resistance could scarcely have resulted differently. Furthermore, had this patient received neither food nor cathartics by mouth from the beginning of his attack he would undoubtedly not have lost his life.

Case 3. A boy six years of age entered the hospital on the seventh day of an apparently mild attack of acute appendicitis. During the preceding three years the patient frequently complained of colicky pains, followed by vomiting. These attacks never lasted more than twenty-four hours.

The patient had received liquid diet throughout the present attack. The right thigh was flexed upon the abdomen and in the region of the appendix a mass could be felt. The abdomen was moderately distended with gas, the abdominal muscles over the appendix were tense. Temperature, 101 degrees F.; pulse, 100.

The patient was placed on exclusive rectal feeding for forty-eight hours, when the abdomen was flat, the pain had disappeared except directly over the appendix. Temperature, 99 degrees F.; pulse, 90.

An incision six centimeters long through the right rectus abdominis muscle exposed an

abscess containing about one ounce of pus and a thick, club-shaped appendix perforated at the end. The appendix was adherent to the anterior surface of the iliacus muscle and the abscess was completely surrounded by the omentum, cecum and ileum. The pus was sponged away without soiling any tissue, the appendix removed and the abscess cavity drained with iodoform gauze and with a glass tube.

The patient progressed normally for twenty-four hours, when he died suddenly without any apparent cause. An autopsy was not obtainable.

One can never hope to eliminate entirely such instances of death. The conditions appeared very favorable for a rapid and complete recovery and there seemed to be no reason for expecting a fatal result.

In one case of sudden death a number of years ago, after an operation for appendicitis in which the appendix was attached to the iliac vein, the result occurred from the loosening of a thrombus of the external iliac vein. It is possible that the same accident happened in the present case.

Case 4. A woman fifty-five years of age, who entered the hospital with a fistula of the cecum due to an acute perforative appendicitis, operated elsewhere three months previously.

The patient's condition was satisfactory after the operation, which consisted in the closure of a fecal fistula in the cecum three centimeters long. Five weeks after the operation, before the drainage wound had completely healed, but after the patient had been out of bed for one week, she suddenly developed gangrene of the right lung, from which she died a week later.

This condition undoubtedly resulted from an infarct due to a thrombus formed as a result of the disease or the operation, but we have been unable to trace the connection, as an autopsy was not granted.

Concerning the operations in all of these cases we have invariably endeavored to reduce the traumatism to a minimum. The surrounding peritoneal cavity has been protected with warm, moist gauze pads. All unnecessary manipulations were avoided. In case of circumscribed abscess the appendix was removed when it seemed as though this could be accomplished safely. The above histories show that several errors of judgment occurred in connection with this feature in this series.

Drainage was used whenever it seemed as though the peritoneum might not be capable of disposing of any infection remaining. In this again there were some fatal errors. It is much better to drain too often than to err in the opposite direction.

Irrigation was not employed in any of these cases because our results have been less satisfactory when this means was frequently employed.

Reiteration of cardinal principles of treatment. It is, of course, impossible to go more fully into the histories in so large a series of cases without making the report unduly long and correspondingly tedious. We believe, however, that enough has been said to make it plain that experience with this series of one thousand consecutive cases, whose treatment was based upon the conclusions previously given, would justify us in urging others to make use of the same principles in treating similar cases.

To those who do not feel justified in subjecting their patients to a form of treatment of which they have not personally seen a practical application we would suggest that they continue to treat their cases precisely as they have up to the present time, but that immediately upon being called to see a case of severe acute appendicitis they carefully cocainize the pharynx by spraying with a two per cent. solution, then wait for five to seven minutes until the cocain has had time to have its maximum effect. That then they introduce a stomach tube and remove any substance which may be present in the stomach by irrigating with warm normal salt solution. That then no food of any kind whatsoever, or catharties, be given by mouth until the patient has been normal for four days, no matter whether or not an immediate operation be performed. The nutrition may in the meantime be carried on by giving a nourishing enema, every three to four hours, consisting of one of the various concentrated liquid foods in the market, dissolved in three ounces

of normal salt solution, through a catheter inserted into the rectum a distance of two to three inches.

We would suggest that this plan be followed in all cases in which the patients or their friends absolutely refuse an operation.

This plan has now been practised by a large number of physicians and surgeons, and all of those who have actually carried out the principles set forth in the above conclusions have found a very marked reduction in their mortality. We have received a large number of letters from physicians testifying to this fact, and many others have personally reported equally satisfactory results.

Our own experience and observation is borne out by many others to the effect that the administration of any form of nourishment or catharties, or both, by mouth has caused an enormous number of deaths in patients suffering from acute appendicitis, and that its prohibition will save a correspondingly large number of lives.

We have been informed by many physicians that before this method was introduced in their practice they had many deaths from acute appendicitis and that now they almost never lose a patient from this cause. When we consider the effect this treatment has had upon the enormous number of these cases that have come under our observation at the Augustana Hospital we readily comprehend these statements.

ACUTE GANGRENOUS APPENDICITIS

Typical case. Patient, twenty-seven years of age, a bookkeeper by occupation, came under care one hour ago. He was then in his residence, a distance of two miles from the hospital, where he was seen in consultation with his physician, who had made the proper diagnosis before requesting consultation. The patient gives the following history:

Family history good. As a child he had suffered from measles, but was otherwise well. About one year ago he suffered an attack of pain in the right inguinal region, accompanied by vomiting and fever, and was confined to bed for about one week. Has been more or less constipated during the past year and has had more or less weakness and pain in the right inguinal region. This was always worse after having eaten heavily. One week ago he had a severe attack of pain, accompanied by vomiting and a slight amount of fever. He was confined to bed for three days. For the following four days he was up and about, and was fairly well this morning when he felt a slight pain before rising. He ate breakfast and at about ten o'clock was seized with most violent distress in the right inguinal region, accompanied by vomiting, chills and fever. Suffers from severe shock, is still having severe pain in the right inguinal region, although he received a hypodermic injection of one-half grain of morphia before coming to the hospital. In the region of McBurney's point there is a great tenderness and the muscles are extremely rigid. His temperature is 100 degrees F. and pulse 102. There is no tumor palpable.

Diagnosis. We have here again a fairly typical condition. A history of a previous acute attack of pain in the right inguinal region, accompanied by vomiting and fever, which must have been sufficiently severe to leave the appendix somewhat impaired. It was not severe enough to warrant a diagnosis of gangrenous or perforative appendicitis, but it might have been due to an obstruction to the lumen of the appendix, resulting from the presence of an enterolith or an ulcer in the cecal end of the appendix. The slight attack a week ago might have been a repetition of the same condition.

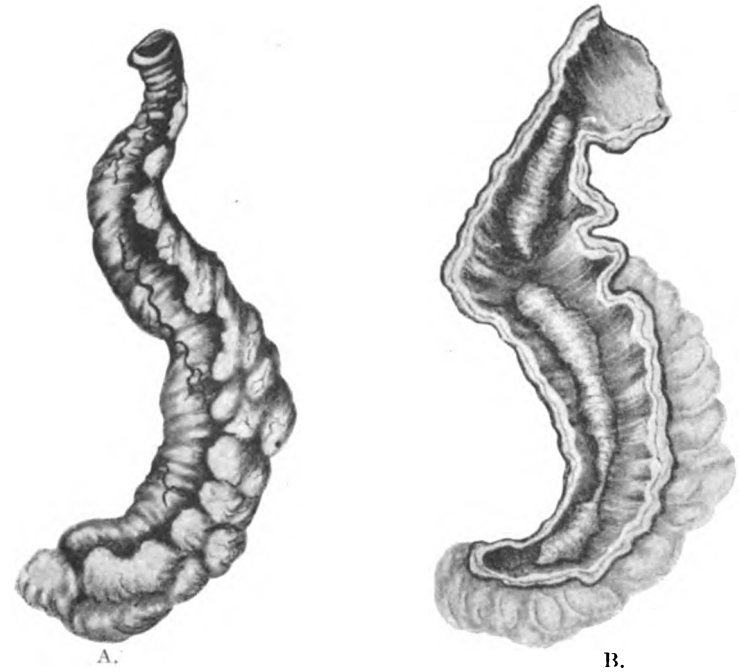
At the present moment the patient is still suffering, but not nearly so much as one hour ago at his residence, where he was fairly in convulsions because of the extreme pain in the region of McBurney's point. The large dose of morphia he received before coming to the hospital serves to disguise the condition somewhat. This, however, does not matter, because there can be no doubt concerning the diagnosis.

The extreme violence of the attack which occurred about ten hours ago and which has not subsided since; the increase in his temperature; the acceleration

of his pulse and the bad appearance of the patient; the great rigidity of his abdominal muscles; the obstruction to the passage of gas, all go to show that he is suffering from a gangrenous appendicitis, or an impending perforation due to pressure from an enterolith or the accumulation of pus in an obstructed ulcerated appendix.

Treatment. Only two forms of treatment can be considered in a case of this character: 1. Immediate operation. 2. Palliative treatment according to the method employed in the previous case by means of exclusive rectal alimentation and consequent elimination of peristalsis.

Judging from the history here given and from the conditions we find upon examination it is reasonable to suppose that at the present time, only ten hours



A. B.

CONSTRICTED APPENDIX.

A represents the vermiform appendix with a constriction near its cecal end. The mesenteriolum extends a little beyond the end of the appendix. The latter is markedly edematous. Fig B represents it laid open, showing fecal concretions in its lumen, and also showing the constriction near its cecal end.

after the beginning of the attack, the infectious material is still confined to the appendix.

The following advantages may be brought forward in favor of an immediate operation in cases like the one before us:

1. The patient will almost invariably get well: it is an accident if he does not recover. 2. He will be able to return to work in one month. 3. He cannot have a recurrence. 4. He cannot have the complications resulting from progressive or metastatic infection. 5. There will be no adhesions with their digestive disturbances. 6. There will be no ventral hernia because drainage will not be required. 7. He will not become an invalid because of one or another of the possible complications.

It is quite different one, two or three days later when the infection has extended to the tissues beyond the appendix, because at that time we would

have to expect trouble for the following reasons: 1. The patient is not certain to recover, even in the hands of the most skillful surgeons. 2. His recovery from the operation is likely to be slow. 3. It may not be safe to remove the appendix after opening the abdomen, hence a recurrence may still occur. 4. The operation may cause an extension of the infection. 5. Adhesions are likely to follow the operation performed at this time because drainage will probably be required. 6. For the same reason hernia frequently occurs after operations performed at this period.

What can we expect in case the patient is not operated immediately, but treated by the preceding method described?

In cases like the one before us, in which we have been compelled to employ this method because the patient or his friends absolutely refused an operation, we have found the pain subside rapidly after employing gastric lavage and that the other symptoms decline within twenty-four or forty-eight hours, or at the latest seventy-two hours, with the exception of the tenderness upon pressure. In some cases a circumscribed abscess formed, which had to be opened externally or it ruptured into the cecum. If permitted to remove the appendix later it would be found eliminated from the general peritoneal cavity by means of adhesions to the omentum, the cecum or the iliacus muscle. If it was not removed later these patients usually had recurrent attacks of appendicitis.

We would consequently say in considering patients in the condition of the one just described that if a safe surgeon is available such patients should invariably be operated on at once for the reasons given, which will undoubtedly become more apparent as we proceed with the operation. It is for this reason that the family physician requested consultation with a surgeon as soon as he had made his diagnosis, and for the same reason we agreed upon sending this patient to the hospital the moment we had concluded the consultation. We have lost no time, for while the patient was on the way to the hospital all preparations for the operation were made here so that we could proceed at once.

Technique. The patient is so tender that it will not be possible to prepare the field of operation before he has been anesthetized. We will consequently proceed with the anesthesia and then prepare the field of operation in the usual manner, being extremely careful, however, not to exercise a sufficient amount of force to complete an impending perforation of the appendix.

Incision. It seems safe in this instance to make use of McBurney's incision described in connection with the previous case, because this will leave the abdominal wall least impaired after the wound has healed. Had the patient experienced several very severe attacks of appendicitis, it might be reasonable to suppose that much space would be required for the removal of the appendix, which could not readily be obtained through this incision. Should we find conditions more complicated after opening the abdominal wall than is to be expected from present indications we shall still be able to secure an increase in the size of the wound.

It is not likely that we will find an abscess outside the appendix directly underneath the abdominal wall, as this is usually accompanied by a condition of edema of the tissues composing the abdominal wall. Nevertheless, it is wise to be exceedingly cautious in making the incision through the transversalis fascia and peritoneum, in order to avoid injuring the underlying intestines which may be slightly adherent either from the attack the patient experienced a year ago or from the present attack, because frequently these adhesions precede the perforation. This process might have taken place during the slight attack the patient had one week ago.

Upon opening the peritoneum we see a tense, sausage-like object projecting forward between the ileum and the lower end of the cecum. It is surrounded entirely by a fold of omentum, being adherent apparently only behind to the cecum and with this to the iliacus muscle. There are no strong adhesions to the omentum, but this structure seems to be loosely agglutinated to the appendix by means of a delicate layer of leucocytic exudate. In stripping away the omentum there is no bleeding and neither the omentum nor the appendix is abraded.

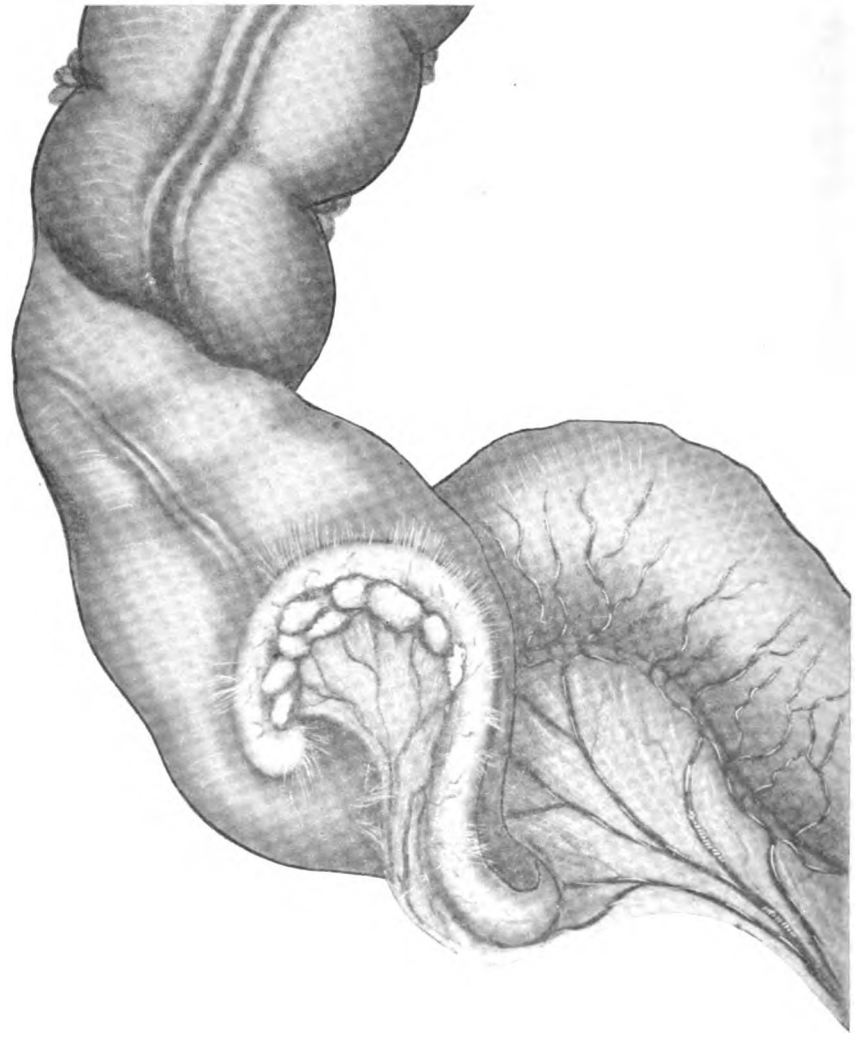
Before attempting to remove the appendix we lift up the abdominal wall carefully and tampon the space around it with soft pads of aseptic gauze saturated with warm normal salt solution, in order to prevent contamination of the remaining portion of the abdominal cavity in case of rupture of the distended appendix. This leaves the other portions of the abdominal cavity virtually out of the field of operation, which is especially important in a case like the one before us, because we know that the appendix contains septic material and we must guard against its introduction into the abdominal cavity. Here we will carefully dissect up the appendix from its distal end, going very cautiously and grasping every bleeding point with hemostatic forceps as we proceed, and applying a fine catgut ligature each time in order to prevent mischief by pulling upon these forceps.

It is often much better to apply two pair of forceps to the cecal end of the appendix and then cut between these, thus severing the appendix from the cecum. Then hemostatic forceps are applied successively to the mesenteriolum and this severed so far as caught in the grasp of the forceps with each successive forceps that are applied. In cases in which the appendix is adherent to the posterior surface of the cecum this method is especially useful in reducing the necessary manipulations.

The appendix is extremely tense, and half an inch from its distal end there is a greyish, dark, discolored point, a circumscribed gangrene. The mesentery extends to the end of the appendix, but is not free. Evidently the inflammatory disturbance of one year ago resulted in the adhesion which attached this mesentery to the lower end of the cecum and to the iliacus muscle. The mesentery is so short that it is not possible to grasp it with hemostatic forceps or to ligate it before cutting, hence it will be necessary to dissect loose the appendix and to grasp the mesenteric artery when it is divided. This is ligated directly and now we have the appendix free in the wound projecting from the lower end of the cecum, like a sausage, three and one-half inches in length and three-fourths of an inch at its greatest diameter. It is slightly curved upon itself and its walls are edematous. After surrounding the appendix with warm, moist gauze pads, in order to protect the wound in case of rupture, we apply two pairs of narrow, long-jawed forceps upon the cecal end of the appendix and cut between. From this point on the operation proceeds precisely as described in connection with the previous case, with the exception that a little greater care is exercised in applying the sutures in the cecum, because of the increased vascularity due to the acute congestion. Unless these stitches are applied carefully there is sometimes troublesome oozing from blood vessels, which are at other times too small to be noticed.

An examination of the specimen removed shows that the appendix is completely occluded at its cecal end on account of cicatricial contraction due to destruction of its mucous lining, which probably occurred during the attack a year ago. The appendix contains pus and mucus and a slight amount of fecal material in flakes. This seems to indicate that the cecal end of the lumen

was not completely occluded until the beginning of the present attack. The mucous membrane lining the appendix is severely congested and dark and a short distance from the distal end there is an area of about half an inch in diameter which is gangrenous. The edematous condition of the tissues in the



ADHERENT APPENDIX.

Represents the cecum together with the ileum and the mesentery of the latter. The appendix is bent upon itself in the form of an interrogation point. It is strongly attached by adhesions to the lower end of the cecum. The lymph glands in its mesentery are greatly enlarged.

walls of the appendix is very apparent on the surface of the section we have made longitudinally through this organ.

It is quite plain that the removal of this organ must be the proper treatment in cases like the one before us, provided this can be accomplished safely.

for the reasons which have been given, but it is equally plain that in such cases it would be an easy matter to infect the general peritoneal cavity, which would of course be a very serious accident.

This case has developed today with great severity, and still the conditions we found were favorable for the protection of the general peritoneal cavity against infection, had peristalsis been eliminated by the method described previously. The appendix was surrounded by the omentum which would have disposed of a great amount of infection and would at least have protected the general peritoneal cavity against infection. It is likely, then, that with this treatment even so violent a case as this would be in the worst instance, has resulted in a circumscribed abscess in the right inguinal region. It is for this reason that we believe laparotomy should be performed for the relief of acute appendicitis only when a safe surgeon is at hand and when the other conditions are such as to make a recovery fairly certain.

The conditions here and in many other similar instances which we have operated during the first thirty-six hours of an acute attack, show how extremely dangerous it is to encourage peristaltic motion of the small intestines by the giving of food and cathartics by mouth. Such action would probably have been followed by a perforation at the point at which the wall of the appendix was gangrenous and this would have been followed by the rapid distribution of the infectious material to distant parts of the peritoneal cavity. Had the gangrenous portion been toward the cecum a perforation would probably have taken place into the lumen of the intestine, which would have been favorable for the recovery of the patient.

Had we found it impossible to remove the appendix safely through the incision which was made in the present case the required space could have been obtained by cutting the outer edge of the fascia covering the rectus abdominis muscle, which would have made it possible to slide the inner portion of the edges of the internal oblique muscle apart a considerable distance. If this still failed to give a sufficient amount of space the internal oblique abdominal muscle could have been cut at right angles to the direction of its fibers.

Of course this incision may be lengthened indefinitely, although always done at the risk of weakening the abdominal wall to a great extent, because a muscle once cut at right angles to its fibers can never be restored to an absolutely normal condition, but circumstances may occur which make it necessary to do this in order to secure a sufficient amount of space to make the removal of an extensively adherent appendix possible.

If such a condition is anticipated it is, of course, much wiser to make the incision through the edge of the right rectus abdominis muscle, as this commands the field of operation equally well and the incision may be lengthened according to the necessities of the case, but if this has not been anticipated it sometimes, though rarely, becomes necessary to increase the space. Then the incision may be carried through the lower or the upper, or through both edges of the muscle, according to the direction in which increased space is desired for the safe removal of the appendix in any given case. If this has been done it is important to secure a closure of the abdominal wound, which will prevent the formation of a ventral hernia.

In order to accomplish such a result we would suggest the following steps: Deep silk-worm gut sutures are first inserted through all layers down to, but not through, the transversalis fascia. These stitches are left untied until the buried sutures have been applied, then they are tied over all, acting simply as

stay sutures. The peritoneum and the transversalis fascia are next sutured with continuous catgut, great care being taken to secure as perfect coaptation as possible, because the transversalis fascia gives valuable support to the abdominal wall at this point and if properly united will aid greatly in preventing the occurrence of a ventral hernia. The transverse incision in the internal oblique muscle is next repaired, making it as nearly normal as possible. For this purpose we have used interrupted stitches of fine, chromicized catgut used double. Ordinary catgut might be absorbed before the muscle ends had been thoroughly united and the retraction of the latter, due to muscular contraction, would leave a point of weakness in the abdominal wall.

It is likely that in aseptic cases these muscles will unite very quickly. We have been compelled to enlarge the abdominal wound in this manner in only a few cases and in these the result has been perfectly satisfactory; but we have a great aversion toward any operation which contemplates the cutting of abdominal muscles at right angles and should not advise such an act except where the McBurney incision seemed to be the best at the time the operation was begun, but proved not sufficiently large to dispose of the conditions found after the abdomen was opened. The further steps in the procedure are the same as described in connection with the previous operation.

ACUTE APPENDICITIS WITH SECONDARY INFECTION OF PELVIC ORGANS IN THE FEMALE

Typical case. The patient is a school-girl, sixteen years of age; has always enjoyed good health, having grown up in the country. She menstruated at thirteen years of age, and was without pain until one year ago, when she suffered from a typical attack of appendicitis. Since then she has suffered severely during each menstrual period. She has had four typical attacks of appendicitis during the past year; the last one began one month ago and she is just now recovering. Her present condition is that of a very well nourished girl, evidently unusually strong and vigorous when in good health; tongue is clear; appetite good previous to recent attack, now absent; heart, lungs and kidneys normal. A slight swelling is perceptible over the region of the appendix, also slight dullness on percussion; vaginal examination cannot be made as patient is a virgin. She has been nauseated, but has abstained from food almost completely during this attack.

Class characteristics. This patient belongs to a class which is not at all uncommon. The characteristic feature lies in the fact that although the first attack was typical of acute appendicitis and the recurrent attacks were similar in character, there is in addition a dysmenorrheic pain, which is more frequently right-sided. The pain may be so high in the abdomen as to indicate a diagnosis of recurrent appendicitis with each menstrual period, but the fact that it occurs regularly at this time usually results in a diagnosis of dysmenorrhea and is more commonly attributed to disease of the ovary and tube than to the appendix. The fact that menstruation was painless and normal previous to the primary attack of appendicitis, and that the patient is a virgin, would indicate that the disease must have begun in the appendix. It may still be confined to the appendix and the exacerbation may be due to the congestion incident to the changes present during the menstrual period. The close connection between the right ovary and tube and the appendix, due to the presence of the appendico-ovarian ligament of Clado, would readily explain the effect of this congestion upon a chronic appendicitis. We have repeatedly seen cases where the cecal end of the appendix was almost completely obstructed and the distal end thereof contained fecal concretions or pus or mucus in which the irritation or congestion due to the menstrual period seemed

to suffice to cause a complete obstruction temporarily each month, and thus produce a mild attack of appendicitis without resulting in a disease of the ovary and tube.

In other cases in which the primary attack of appendicitis is severe enough to result in an infection extending beyond the vermiform appendix the conditions found are quite different. There may have been a perforation of the appendix and some of the septic material escaping from the immediate vicinity of the appendix into the pelvis may there have been taken up by the fimbriated extremity of the Fallopian tube, through which it may have been carried in the direction of the uterus by means of the ciliated epithelium lining this tube. The infection may have been sufficiently violent in character to destroy a portion of the lining of this tube, and thus have resulted in an obstruction, or an adhesion may have been formed between the fimbriated extremity of the Fallopian tube and the ovary, or between any of the other pelvic organs, or directly between the appendix and the Fallopian tube; all or any of these organs may have become adherent to the omentum.

Indications for operation. The increasing severity of the attack, and the fact that although the patient has recovered from the last seizure, she still has a perceptible mass in the region of the appendix, would indicate a sufficient amount of pathological change to warrant the removal of the diseased appendix. It seems, however, that the severe dysmenorrhea which has recurred regularly with each menstrual period since the first attack of appendicitis should be seriously considered.

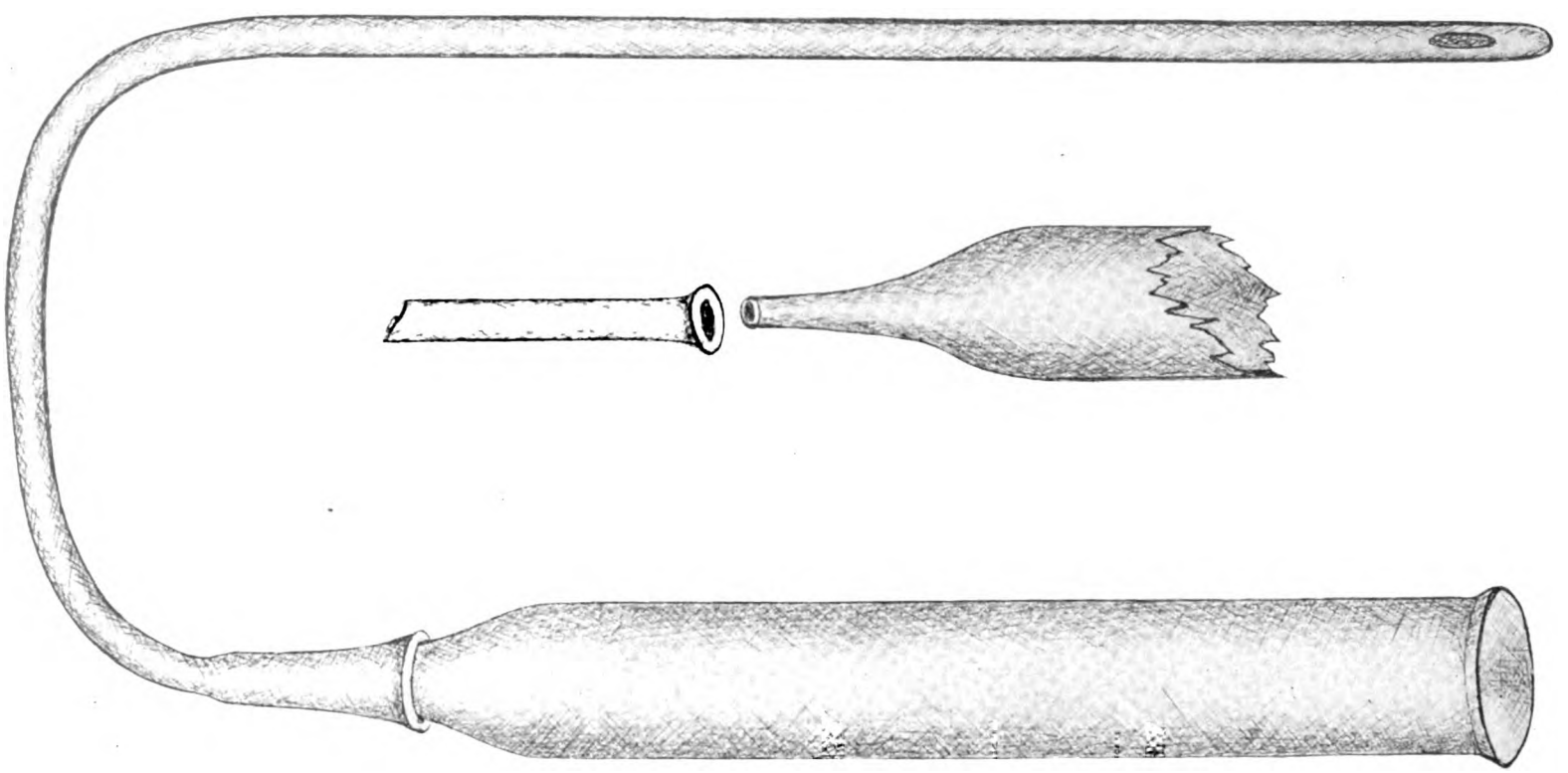
This condition is undoubtedly due to the secondary involvement of the right ovary and tube. If the patient is not relieved of the cause of this severe suffering, which occurs at such short intervals, she will undoubtedly soon become a neurotic wreck, because she will soon be unable to recover fully from one attack before the beginning of the next one.

It is also likely that many cases of sterility result from the infection of the Fallopian tubes having its origin in an appendicitis; hence the sooner the latter condition is eliminated the greater the likelihood of averting such a result. This seems of sufficient importance to influence our plan of treatment of acute or recurrent appendicitis in young girls. The possibility of involvement of the pelvic organs, with their special complications, should demand the removal of the diseased appendix more imperatively than in male children.

We have also observed many times that these children were badly developed physically and mentally when they came under care for the removal of an appendix which had been diseased to a slight extent for several years. The history would show that there had been little or no progress in the child's physical and mental development for several months or years. Many of these cases develop rapidly after removing the diseased appendix, often times gaining more in six months than they had in the previous two or three years.

In many patients suffering from ovarian cysts we have found the remnants of an appendix, once perforated or partly destroyed by gangrenous appendicitis. It is possible that the cicatricial tissue which formed upon the surface of the ovary because of the peritonitis in this vicinity secondary to the appendicitis may be responsible for the formation of some of these cysts.

The same is true of extra-uterine pregnancy, although in this condition there is more commonly a history of an infection of the Fallopian tubes through the uterine cavity.



GLASS SYRINGE ATTACHED TO SOFT RUBBER CATHETER TO BE USED IN RECTAL FEEDING.

Full size. The catheter is introduced a distance of two to three inches and the nourishment is poured into the syringe and permitted to enter by its own weight.

Technique. In this case it seems wise to make the incision through the outer edge of the right rectus abdominis muscle, because we may require a considerable amount of space through which to safely remove an extensively adherent appendix. Moreover, it may be desirable to remove the right ovary and tube if they are sufficiently involved to make their complete recovery to normal unlikely. This incision can be made as short as desirable until the conditions have been determined, and then it may be lengthened upward or downward as indicated by the circumstances.

The mass which we were able to palpate through the abdominal wall consists of the omentum surrounding the appendix and the lower end of the cecum, and adherent to the lower end of this mass we find the right Fallopian tube, which is closed at its fimbriated extremity, and the ovary, which is severely congested and twice the size of the left ovary, which is free and normal.

In order to prevent an infection of the surrounding portions of the peritoneum we tampon these away with a large piece of moist aseptic gauze. It is now one month since the beginning of the last attack, consequently the pus which may be present is not likely to contain any very virulent microorganisms. It is, nevertheless, wise to take the same precautions against an infection. We will now proceed to follow the longitudinal band on the anterior surface of the cecum as the most reliable guide to the location of the appendix, being careful to do as little mischief as possible in loosening the adhesions.

As we loosen the omentum a small quantity of pus is beginning to escape, which we sponge away with great care before there is any chance of causing an infection. The abscess contains about half an ounce of pus and a fecal concretion the size and shape of an olive stone, and the perforated appendix which is constricted at the cecal end and somewhat club-shaped at its distal end. We ligate the portion of the omentum which helps to form the abscess wall and treat the appendix as in the previous cases, after carefully separating it from its adhesions to the lower end of the cecum, to the anterior surface of the iliacus muscle and to the right ovary and Fallopian tube, which have been involved secondarily. When the perforation of the appendix occurred some of the pus evidently escaped into the pelvis and was taken up by the fimbriated extremity of the Fallopian tube, becoming infected. The fimbriæ became adherent to each other and to the ovary, and to the lower end of the adherent mass.

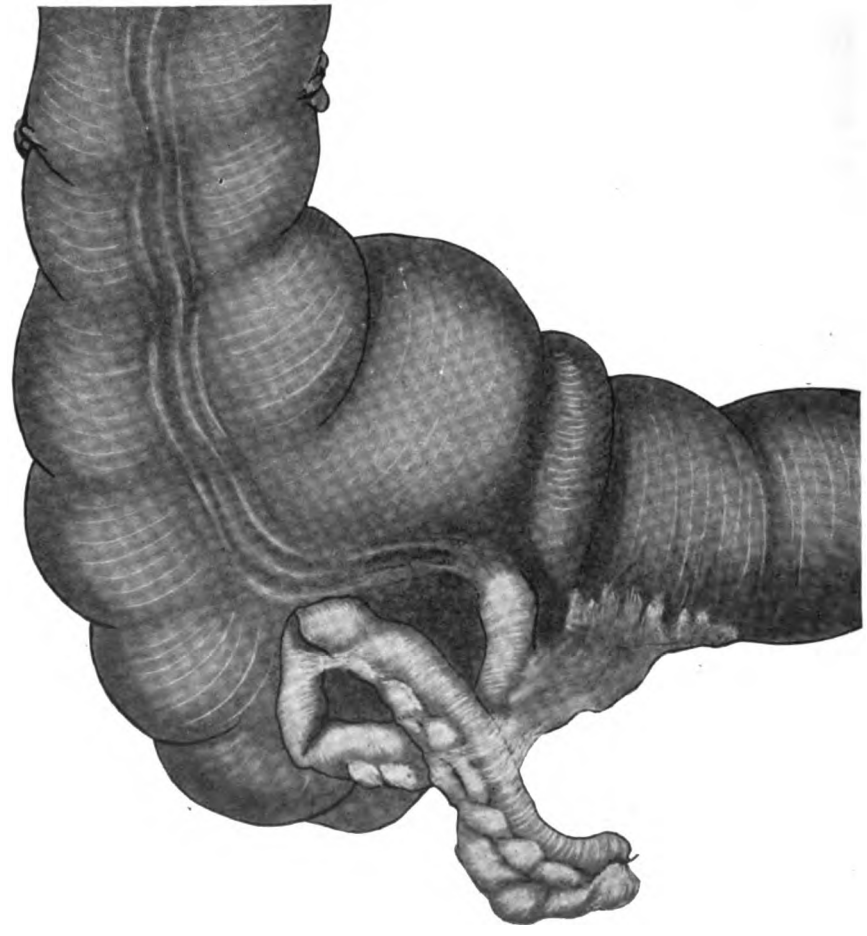
Occasionally it is better to sever the appendix at its cecal end and to invert the stump and close the defect in the cecum as described in the previous operations, and then to enucleate the appendix, because in this manner the cecum may be pushed out of the way and more room gained, which will serve to facilitate the enucleation. The same method may sometimes be employed for the removal of an infected Fallopian tube and ovary, the enucleation being started from the uterine side, the tube being first severed at the uterine end and then enucleated from within outward.

In enucleating the inflamed adherent appendix it is important to bear in mind the fact that the appendicular artery, which is found in the remnant of the mesenteriolum of the appendix, is a vessel of considerable size, and that a fatal hemorrhage may occur if this vessel is not thoroughly controlled. The tissues are often so fragile that it is difficult to grasp this artery with hemostatic forceps without crushing it off and thus increasing the hemorrhage. If this fact is borne in mind, however, it is possible to grasp this vessel and ligate it safely.

Ordinarily, all of these steps may be carried out safely if the wound is made sufficiently long to permit the operation to be performed in plain sight;

if the other portions of the peritoneal cavity are carefully tamponed away; if the appendix is located without unnecessary manipulations by using the longitudinal band on the anterior surface of the cecum as a guide and if the entire operation is performed without unnecessary manipulation.

With increasing experience each surgeon learns to recognize his own ability



ADHERENT APPENDIX.

Represents the vermiform appendix bent upon itself, making several sharp angles, held in position upon the lower end of the cecum by strong adhesions, one of the latter extending over upon the ileum. The end of the appendix is free. The mesenteriolum is narrow, but it extends to the end of the appendix.

in these procedures and can determine with a fair degree of certainty how much he can safely undertake to do in any given case.

It would, of course, be much better simply to drain the abscess and later to remove the appendix, than to do the thorough operation, if this seemed safer in any given case, because a second operation for the removal of the appendix could be very safely performed at a future time. This, however, must be left to the judgment of the surgeon who happens to perform the operation, as the point to be determined is not what is the best treatment

for such cases in general, but what is the best treatment for the case under consideration with the skill and experience at hand. The general principle, however, is applicable to these, as to all cases in surgery, that, other things being equal, the more thorough the operation, the better.

Drainage. Although we have removed this appendix, the infected omentum, the ovary and the tube without contaminating any other portion of the peritoneum, and although we have apparently removed all infectious material, the question whether or not it is wise to drain must still be considered. The fact that an abscess has existed makes drainage permissible. In our own work, we drain much less frequently now than in former years, yet when there is the slightest doubt in any given case we always drain.

Should we drain in this case through any portion of the abdominal wound which extends through the edge of the right rectus abdominis muscle a hernia would very likely result, because the connective tissue formed in the closure of the drainage opening would be very likely to give way. We consequently make a little incision one inch in length parallel to the fibers of the external oblique muscle two inches to the right of McBurney's point. This incision is carried through the fibers of the external oblique muscle down to the internal oblique, the fibers of which extend at right angles to the former. These are also separated and then a small opening is made in the transversalis fascia and peritoneum. Through this opening we carry a glass drainage tube, covered with one or more layers of iodoform gauze, to a point just below the cecum, from which the abscess was removed. What is left of the omentum is then carried over this surface and then the tampons are removed and the abdominal wall is closed in the usual manner.

After-treatment. The drainage tube is removed any time between the second and the fifth day, and the gauze one or two days later, when the drainage wound is permitted to heal. Having been made without cutting any muscle fibers, this wound will never cause a hernia, because the edges of the split fibers will be drawn together as a result of muscular contraction, and thus the small opening will be efficiently and permanently closed.

For the first three days the patient will be sustained entirely by means of rectal feeding, nutrient enemata being given every four hours, as described before. If the patient is normal at the end of this time a moderate amount of liquid nourishment will be given by mouth at regular intervals, but if not normal at the end of this period the exclusive rectal alimentation will be continued. In case of pain morphia can be safely given, preferably by hypodermic injection so long as no food is given by mouth.

Complications. In a few cases we have seen both ovaries and tubes, as well as the uterus and bladder, involved secondarily in acute perforative appendicitis. The treatment must, of course, contemplate the relief of all of these complications.

Where it is apparent, before the abdomen has been opened, that both ovaries and tubes are secondarily involved, it is usually wise to choose the median incision, because from this the affected parts can all be reached, except when the appendix is adherent to the posterior surface of the cecum. However, we have never encountered one of these cases with a secondary involvement of both ovaries and tubes in which the diseased condition of these organs could not be recognized by a vaginal examination. In that case the median incision would, of course, be chosen.

In order to emphasize its importance once more, it is suggested that in all intra-abdominal operations performed for the relief of dysmenorrhea, especially if this is more strongly marked on the right side, it is wise to examine the appendix, because very frequently a diseased appendix is the sole cause of dysmenorrhea.

In one instance in which there was a free discharge of pus, filled with colon bacilli, from the vagina, we found that the fimbriated extremity of the right Fallopian tube had grasped the gangrenous end of the appendix and that this end had never healed, so that a continuous tube extended from the cavity of the cecum to the cavity of the uterus.

APPENDICITIS IN CHILDREN

There are certain features in connection with appendicitis in young children which require especial attention, for if looked upon from the same standpoint as in adults our results will not attain the highest degree of satisfaction.

History. Frequently a child that has been in most excellent health, whose general appearance indicates no disturbance, whose nutrition is good, and who is in no way suffering, suddenly develops a most violent attack of acute appendicitis. This can be explained in the following manner: The appendix in these children is usually large, but the cecal end is much the narrowest portion of the lumen. This favors the formation of an enterolith, which eventually either obstructs the cecal end of the lumen and brings about an acute appendicitis or it causes an ulcer, resulting from pressure-necrosis, with the same ultimate result.

In many the mesentery of the appendix is very short, which still further facilitates necrosis of the portion projecting beyond the end of the mesentery, because in case of a thrombosis of one of the vessels in this portion there can be no compensatory circulation, while this can readily be established when the mesentery extends to the end of the appendix.

Diagnostic error. One peculiarity of appendicitis in children is the fact that the attack is almost always looked upon by the parents and friends, and frequently by the physician, as a case of violent, acute gastritis or enteritis, resulting from some indiscretion in eating. (In most cases the little patient has indeed eaten an unreasonable amount of some especially indigestible substance just before the attack began). This is so common that one rarely sees these young appendicitis patients in whom the correct diagnosis was made from the beginning of the attack.

The omentum in young children is very small and not very substantial, hence it cannot be of as much use in separating the diseased appendix from the general peritoneal cavity as in the adult, and consequently it is necessary, in cases which come too late for an early operation, to watch closely from day to day, and if a circumscribed abscess forms to drain it.

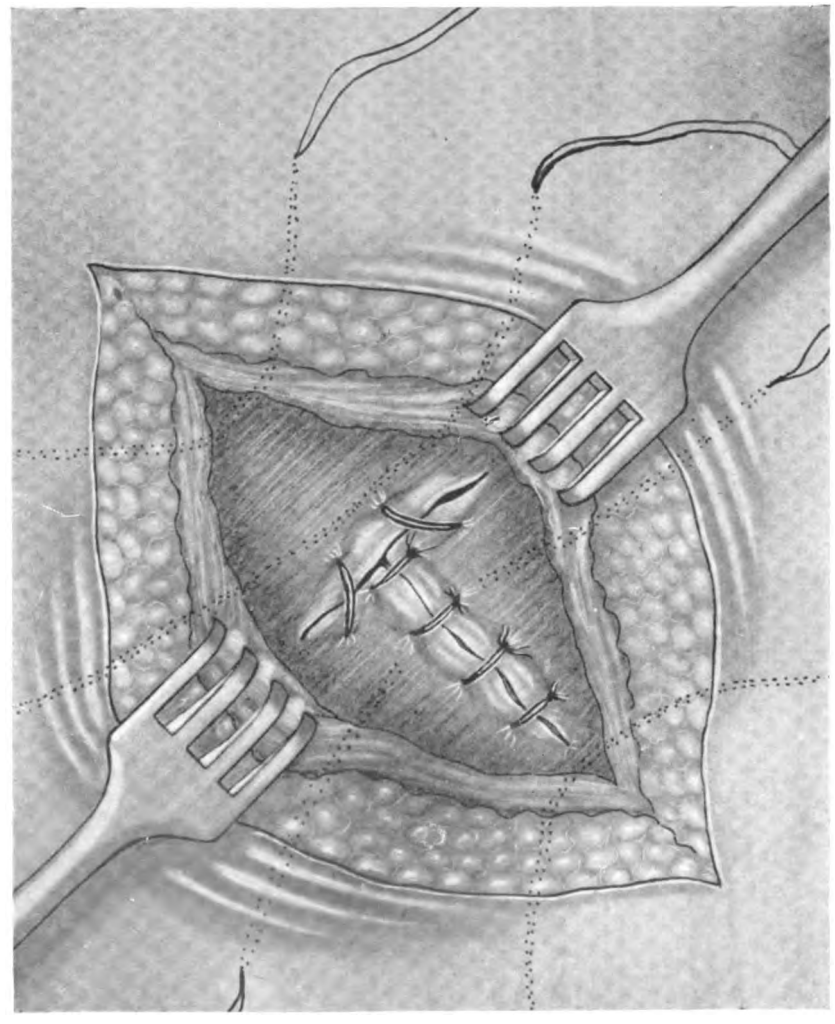
Another difficulty encountered in the treatment of children is their fear of the stomach tube. It is important to employ gastric lavage, but many willful and badly brought-up children will struggle so violently against its use that even with cocain anesthesia one may not be able to accomplish the task without danger of injuring the patient because of the struggle required. By pinning the child into a large sheet which passes around the entire body from its neck to its feet and placing the child on its right side, it is usually possible to make gastric lavage safely.

To a slighter extent the same difficulties are sometimes encountered in rectal feeding.

The most important point, however, is in dispelling the idea that a severe pain in the region of the stomach in children, coming on after taking indigestible food, is due to gastritis and is consequently of little importance, because so often a careful examination will demonstrate it to be a gangrenous or perforated appendicitis. This condition frequently occurs in children not more than four years of age. We have seen a number of cases much younger, one as young as seven months, and the accompanying history of a case observed

by Dr. W. B. Helm, of Rockford, Illinois, which is quoted because of its unusual interest, shows that it may occur in those still younger.

This patient, a boy three months old, was seen by Dr. Helm, January 5, 1902. He had suffered almost constantly since birth, crying much of the time, night and day. Frequent tenesmus, although bowels were easily regulated. The mother's milk did not agree and various



ABDOMINAL INCISON.

Represents the method of applying interrupted sutures in order to restore the internal oblique abdominal muscle, in the same case the external oblique being held out of the way by means of retractors.

prepared foods were tried. The child took food ravenously, but never seemed satisfied. There was no gain in weight and some fever persisted most of the time. When the child was five weeks of age the local physician was called and detected a right oblique inguinal hernia. There was apparently no trouble in reducing it and he tried various forms of retentive apparatus. Still the crying, straining and fever continued. Seven weeks later the patient began to fail rapidly, and Dr. Helm found it with a temperature of 103° F. and pulse varying from 160 to 190. The child weighed only eight pounds and still cried most of the time. There was a hernial protrusion the size of a small hen's egg. The bulk of the mass could be readily

returned, but a small object in the inguinal canal remained. It seemed like an undescended testicle, but both of these organs were found to be in the scrotum. Repeated trials failed to return it to the abdomen, so an operation was advised. On opening the canal the doctor found that the reducible portion was the head of the colon, and the irreducible part was the appendix, slightly adherent and greatly congested. He removed the appendix and closed the canal by the Bassini method. The pain was apparently lessened at once, the fever disappeared on the third day and the child gained two pounds during the first ten days and made an uninterrupted recovery. It seems as though in this case, judging from the history, the appendicitis may have been congenital.

In connection with appendicitis in children, we believe it would be best to lay down the rule that in every instance a child should be subjected to a careful physical examination when suffering from digestive disturbance, or from pain in the abdomen from any other supposed cause.

Many of these children give a history of perverted appetites and of feeling sick or nauseated after meals for some time before the acute attack.

APPENDICITIS IN OLD PEOPLE

Fortunately it is but seldom that acute appendicitis occurs in those very advanced in years. We have seen one case of perforative appendicitis in a woman sixty-eight years of age.

In the treatment of these cases the fact that old people do not well bear confinement to bed in the recumbent position should be borne in mind. These patients should be placed in a semi-sitting posture in order to prevent hypostatic congestion of the lungs. If it seems at all safe it is well to operate these cases at once in order to shorten their confinement as much as possible. But these patients are usually very obese, which still further reduces their chances of recovery. It is consequently necessary in every given instance for the surgeon to choose between two evils, and the better his judgment the more likely he will be to choose wisely. If the operation be postponed it is well to reduce the amount of fat in the abdominal wall of obese patients by proper treatment and to remove the appendix after the patient has recovered from the acute attack. The method for reducing the weight in obese patients is discussed fully in another section.

COMPLICATIONS OF APPENDICITIS

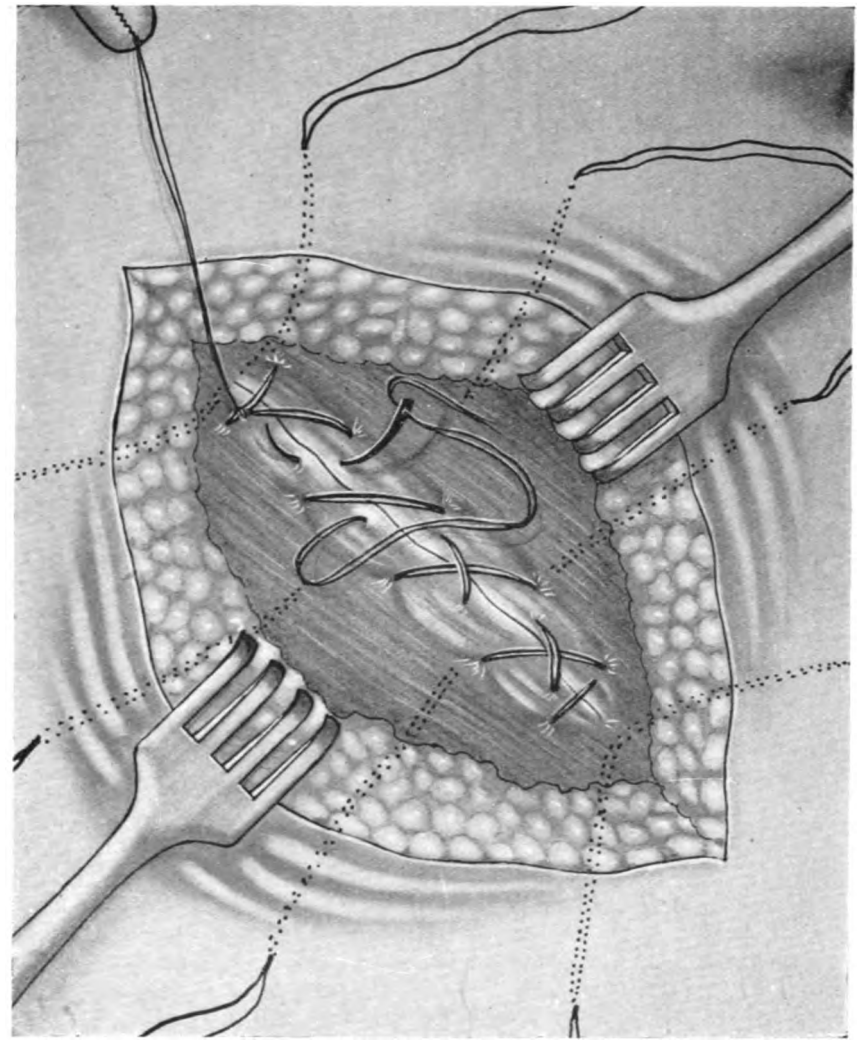
Any condition which may result from infection, either direct or metastatic, may result as an immediate complication of appendicitis. Of these the most common is circumscribed or diffuse peritonitis, with or without the formation of abscess. This complication, as has been stated before, is greatly reduced in its importance if neither food or cathartics are given from the beginning, because this eliminates the mechanical distribution of infectious material by means of peristalsis. It also prevents the disturbance of septic thrombi, which may be present in the veins at the seat of inflammation, and which might be loosened were food and gas forced through the ileo-cecal valve; consequently metastatic infection is also greatly reduced in this way. Metastatic abscesses complicating acute appendicitis may develop at any point in the body and should be treated as though they had occurred in connection with the primary infection.

Many other complications may take place, because the presence of an acute or chronic appendicitis naturally does not preclude the occurrence of any other pathological condition which might be present in a patient not suffering from appendicitis.

Strangulated hernia. A considerable number of cases of acute appendicitis complicating strangulated hernia have been reported. We have encountered

gangrenous appendices, both in strangulated femoral and inguinal herniæ, and in one case of irreducible umbilical hernia.

We have also operated upon one case of inguinal hernia which was com-



CLOSURE OF MCBURNEY INCISION.

By suturing the fascia of the external oblique muscle separately, as indicated in this plate, there is one strong layer which is perfectly restored, which will compensate for a portion of the defect in the internal oblique.

The deep silkworm gut sutures are drawn double. It is scarcely necessary to take this additional precaution, but the support from this source is undoubtedly of value until the injury to the internal oblique muscle has had time to become repaired. The deep sutures are tied after all of the layers have been separately united with catgut sutures.

plicated with suppurative epididymitis and orchitis, together with an acute suppurative appendicitis in a case of cryptorchism. In this case the cecum was so low that by lengthening the herniotomy incision upwards by dilatation it was possible to remove the appendix through this opening. An orchidec-

tomy was performed, the wound drained and tamponed with iodoform gauze for a week, then it was sutured secondarily. The result was perfect.

Typhoid fever. In cities where typhoid fever is endemic it is not a very uncommon occurrence to find difficulty in making a differential diagnosis between typhoid fever and a mild attack of appendicitis, or between the presence of a perforative appendicitis and a perforated typhoid ulcer. In case the differential diagnosis between acute appendicitis and perforative typhoid ulcer cannot be made positively an abdominal section is indicated, because if the former condition is found, this treatment is proper, while if the latter exists non-operative treatment would almost certainly bring about a fatal result.

The Widal test may be used for making a differential diagnosis, but if the patient has had typhoid fever at some previous time the Widal test will often be positive, and this will be misleading. Moreover it is often not wise to postpone operative treatment long enough to make this test. It is also to be borne in mind that the Widal test is applicable only to advanced cases of typhoid fever, hence, its value is greatly reduced.

In several instances we have observed patients suffering from plainly marked attacks of acute appendicitis in which a typical attack of typhoid fever followed immediately. In each of these cases the patient had consumed great quantities of infected water during the beginning of his sickness. The fever accompanying the appendicitis caused severe thirst, and the great quantity of water containing typhoid bacilli consumed during the time had undoubtedly brought about the typhoid infection.

We have, of course, seen many cases of simple appendicitis which had been diagnosed typhoid fever, and vice versa, but the cases referred to above did not belong to this class.

In some localities, especially in great cities, in which a large proportion of the population regularly drinks unsterilized water infected with typhoid bacilli, it is wise to bear in mind the fact that typhoid fever and appendicitis may occur at the same time in the same patient. Of course, the same thing might happen by accident with almost all of the other intra-abdominal conditions. We have encountered a renal calculus, an extra-uterine pregnancy, a gastric ulcer, as well as all the varieties of tumors occurring in the uterus and adnexa, in connection with acute appendicitis. It is likely that in each case the fact was due simply to a coincidence and that no causal relation existed between the two conditions.

Floating kidney. The presence of an abnormal mobility of the right kidney, either with or without general enteroptosis, is not at all uncommonly found in connection with chronic recurrent appendicitis. It is possible that the increased intra-abdominal pressure which has to be employed to overcome the obstruction to the passage of gas and feces through the ileo-cecal valve in these cases may be responsible for the mobility of the kidney, or it may simply be a coincidence.

In many there are extensive adhesions which interfere seriously with the fecal circulation, causing the intestines and the stomach to be constantly distended with gas, and this may help to account for the mobility of the kidney.

Thrombo-phlebitis. Occasionally in cases of appendicitis which have not been operated, and more frequently following operation, there is a thrombo-phlebitis of the external iliac vein. Ordinarily the condition does not materially interfere with the recovery. The same precautions should, however, be employed as in a thrombo-phlebitis from any other cause. If a small portion of the thrombus is displaced, it is likely to cause serious trouble and may even give rise to an embolism of the pulmonary artery, causing sudden death. In this condition the greatest danger to the patient results from the fact that

laymen are likely to rub or massage the affected part and thus may loosen a thrombus.

The part should be placed at absolute rest and under no circumstances should rubbing or massage be permitted over the affected area.

Pregnancy. A complication which is usually mistaken for puerperal fever results from the coincidence of an acute gangrenous or perforative appendicitis with the delivery of a pregnant woman. We have observed a number of cases in which the differential diagnosis could not be positively made, but in four cases we were able to demonstrate gangrenous appendices at the operation, which should be made at once if a positive diagnosis can obtain, and it seems reasonable to add that if the absence of acute gangrenous appendicitis cannot be made with certainty, operation is justifiable.

Carcinoma. Primary carcinoma of the appendix seems to be sufficiently frequent in occurrence to require some consideration, although the condition can probably not be diagnosed until the abdomen has been opened and then only if quite advanced. According to the statistics of McCarthy careful microscopic examination will reveal about one-fourth per cent. of all appendices surgically removed to be carcinomatous, and less than one-fourth of these, or less than one in one thousand, will be recognized at the operation as containing a malignant growth. Our knowledge of their presence should, however, cause the surgeon to examine each specimen in order to insure especially thorough removal in case malignancy be suspected.

Hematogenous infection as a cause. In the foregoing pages, occlusion of the lumen of the appendix is offered as the chief etiological factor in the production of this disease. In our experience this is the most frequent causative factor. Recently, however, Rosenow and other investigators have brought forth evidence to show that appendicitis may be the result of a hematogenous infection, various pathogenic bacteria gaining entrance to the blood stream and then, after lodging in the appendix, multiplying and producing an acute appendicitis. Certain strains of bacteria, especially streptococci, seem to develop a definite selective affinity for certain tissues. Thus, following acute tonsillitis, streptococci, which multiply in the tonsils, develop a selective affinity for lymphoid tissue in other parts of the body, and since the appendix contains a large amount of lymphoid tissue, these organisms may lodge here and set up an acute inflammatory process, in other words, an acute appendicitis.

DIFFUSE PERITONITIS

Of all the complications of acute appendicitis the most dangerous is diffuse peritonitis. Moreover, acute perforative and gangrenous appendicitis and its treatment by the use of catharties, together with the administration of some form of food by mouth, or the operation of these cases after beginning diffuse peritonitis has become established, which occurs usually in severe cases from the second to the fifth day, have given rise to more instances of diffuse peritonitis than all other causes combined; hence it may be proper to discuss the subject at this point and to emphasize especially the steps required for it prevention.

PREVENTION AND INHIBITION OF PERITONITIS

At the very beginning it seems important to emphasize the fact that treatment must be directed almost entirely toward prevention and inhibition of peritonitis, because this will reduce the mortality from this disease enormously. Physicians in general practice who have appreciated this fact have almost completely eliminated deaths from peritonitis in their practice, while

others whose attention has been directed toward the cure of peritonitis have succeeded in reducing their mortality from this disease only to a very slight extent.

Prevention must depend largely upon a careful early diagnosis, and inhibition upon early treatment, in cases in which a circumscribed or a beginning diffuse peritonitis exists when the patient comes under the physician's care, by definitely planned methods which will prevent diffusing septic material from its circumscribed location to other portions of the peritoneal cavity.

There must, of course, always be a certain percentage of mortality because some cases will not reach the care of the physician until they are beyond the period at which prevention or inhibition is possible, but this class is constantly decreasing because physicians are becoming more thorough in examining their patients, and laymen are learning the importance of early intervention. There will also always be a percentage of mortality in cases in which the primary infection is overwhelming, as in some cases of perforation of gastric, duodenal or typhoid ulcers, or ruptured gall bladder, although in all of these early closure of the perforation, sponging away the extravasated substance and thorough drainage has reduced the loss from this source to a marked degree. Moreover, typhoid perforations are becoming very scarce in communities which are sufficiently civilized not to drink water infected with sewerage, and among those who will not permit their food to be infected by flies.

The mortality from peritonitis at the present time is by far greatest in cases in which the infection comes from the vermiform appendix and in those of puerperal origin.

Medical literature shows absolutely that there is no form of treatment of much use in peritonitis which is so far advanced that the patient is suffering to a marked degree from general sepsis. We might as well think of saving a wooden building after fire has partially destroyed all the walls and floors. It is unreasonable to expect good results under these conditions.

Our attention must be directed first toward prevention, which is possible in most cases, because peritonitis results from conditions which can be recognized and permanently relieved before they have given rise to the disease, by making a careful physical examination in every case suffering from intra-abdominal conditions. A perforation of the gall bladder is always preceded by gastric disturbances which should result in a physical examination, which, in turn, should establish a diagnosis of cholecystitis or cholelithiasis. An operation for the relief of this condition would prevent the perforation and peritonitis.

The same can be said of other conditions which later result in peritonitis.

Value of the physical examination. No physician has a right to prescribe for the relief of any intra-abdominal condition without having made a physical examination.

The calamity which may follow the crime of a superficial examination in chronic cases, after weeks or months, may follow after days or hours in acute cases.

By giving something for the relief of indigestion in the chronic case, without a physical examination demonstrating the presence of a gastric or duodenal ulcer or gallstones, the physician may be responsible for the peritonitis which may occur weeks or months later as a result of perforation. Quite as certainly, by giving a cathartic for acute indigestion without a physical examination in a case of gangrenous appendicitis, he may cause a distribution of the infectious material over the entire peritoneal cavity by stimulating peristalsis, producing a diffuse peritonitis. This in turn may destroy the life of the patient in a few days. For a fairly trained diag-

nostician it is possible to recognize all of these conditions, whether they be acute or chronic, in time to prevent or inhibit peritonitis if he makes a careful examination when the patient first comes under his care. At the end of this chapter a number of conclusions will be found, which contain the various elements to be considered in planning the prevention and inhibition of peritonitis.

At this point the part played in the production and acceleration of peritonitis by the use of cathartics will be discussed more extensively. Undoubtedly, many patients lose their lives from general peritonitis because they were given either cathartics or food, or both, by mouth after the beginning of the peritoneal infection. In the very large number of cases which have come under our observation, there has not been a single instance of death from peritonitis in which neither cathartics nor food had been given by mouth after the beginning of the attack, which seems to be a most important observation.

The introduction of cathartics in the treatment of peritonitis. Nearly forty years ago the phenomenal success in abdominal surgery experienced by Lawson Tait was attributed by many to the fact that he administered cathartics to his patients directly after performing laparotomies, and the fact that his patients regularly recovered without symptoms of peritonitis after ordinary abdominal operations performed for nonseptic conditions, while other surgeons lost similar patients constantly from peritonitis at this period, led to the conclusion that cathartics prevent peritonitis. He says, in the Hastings essay for 1873, "The administration of laxatives within a few hours after the operation is becoming quite a common practice with me, this innovation, in my opinion, being possibly conducive in some measure to my increased success."

This theory that cathartics can prevent or inhibit peritonitis appeared very frequently in essays and in text-books during the following quarter of a century, although, in the meantime, every surgeon had learned the fact that the absence of peritonitis following Tait's operations was due to the circumstance that he was a clean, rapid surgeon, who neither infected his patients nor unnecessarily traumatized the peritoneum, and that because neither infection nor trauma were present, the cathartics he gave were harmless.

During these years many medical books and articles contained statements similar to the following referring to the treatment of acute appendicitis. It will not be necessary to quote from more than one of the best authorities who now never gives either cathartics or food in acute infection of any portion of the peritoneal cavity because, during this period, all of the best authorities, like Deaver, Murphy, Minter, Fowler, Morris, made similar statements in their books. "The bowel must be kept clean from irritating fecal matter, by enemata if possible, by a good cathartic if necessary." "Evidence is not wanting of successful results obtained by medical treatment, especially in the use of saline purgatives."

Only patients in whom the infection was still confined to the appendix and those in whom the infection had been sufficiently circumscribed by strong adhesions to make dissemination of septic material impossible, which, according to the careful studies of Staunton, rarely occurs before the seventh day, furnished safe cases for this treatment.

At that time this surgeon's mortality in operations for appendicitis was also ten per cent., and since prohibiting all forms of food and cathartics by mouth, and giving normal salt solution by rectum, his mortality has been reduced to less than one-fourth of this percentage in precisely the same class of cases.

Mode of action of cathartics. In cases in which the primary infection comes from a circumscribed point like the appendix, or a leaking pus tube, or a nearly perforated gastric, duodenal or typhoid ulcer with slightly adherent omentum covering the point of danger, the conditions are fair for obtaining a circumscribed instead of a diffuse infection. The same is true in a gall bladder with a gangrenous mucous lining.

In case of the appendix and the Fallopian tube, the cecum, sigmoid and the omentum are likely to confine the infection to the pelvic portion of the abdominal cavity. In all of the other instances the burden of the work of protection falls upon the omentum, but so long as the infection is in one circumscribed location, the entire free portion of the omentum can and will arrange itself about this point and will prevent the infectious material from passing on to other portions of the peritoneum. All of the physiological forces become active to prevent the escape of this septic material to other portions of the peritoneal cavity. The colon becomes filled with gas and acts as a cofferdam. The small intestines, if not disturbed by cathartics or food, form an embankment about the diseased area.

These conditions have been observed innumerable times by surgeons who have operated in acute cases.

The nausea prevents the patient from taking food unless this is forced upon him by some foolish friend or unless it is prescribed by some incompetent physician.

The abdominal walls become rigid and form an anterior splint. Everything is as favorable as can be for the process of repair, which consists in the concentration of the activity of millions of leucocytes in the infected area and the production of antibodies in the blood and the limitation of nutrition of the septic micro-organisms to an area in which they will soon become reduced in virulence.

It is true that the alimentary canal may contain septic material, but this will soon be excreted through the stomach and can be readily removed by the use of gastric lavage. If no further food of any kind is given by mouth, the small intestines will soon be free from septic material, and gastric lavage applied once or twice will usually suffice to remove the septic material excreted into the stomach, although in rare instances it is necessary to repeat this lavage several times a day for several days.

Were one to continue placing food in the stomach during the progress of the disease, then there might be some doubt as to the choice between the two evils of leaving a quantity of decomposing substance in the alimentary canal to poison the patient, or forcing it out by means of a cathartic and incidentally killing the patient by carrying the septic material from this circumscribed area to the other peritoneal surfaces by the peristalsis caused by the cathartic.

Since it is possible to supply the necessary amount of nourishment by rectal alimentation and a sufficient amount of fluid by the continuous normal salt solution introduced by the drop method into the rectum, or by any one of the numerous methods which have been described by others, there is no reason why one should risk harm by introducing food or cathartics by mouth. No good can come from it because it is not needed. That harm does come from it is not only plain from the theoretical reasons, but has been demonstrated in a large number of cases.

This applies to all cases without regard to the form of surgical treatment that may be chosen in any given individual.

Whatever surgical treatment may be contemplated in case of any form of existing peritonitis, the results must be better if the infection is not diffused by peristalsis. There can, therefore, be no reason why peristalsis should

be initiated by the use of cathartics. Even the smallest amount of cathartic may change a harmless circumscribed infection into a serious diffuse peritonitis.

One demonstrable change consists in the rapid increase in leucocytosis even after the administration of a small amount of cathartics. One-tenth grain of calomel with one grain of soda may increase leucocytosis several thousand within a few hours, and the same is true of other cathartics and also of enemata, except when given by the drop method. We have had an opportunity to observe this in a hospital whose beds are open to the general practitioners of the community in which it is located. Some of these practitioners give cathartics habitually as a form of initiative treatment while they are trying to think what form of treatment is indicated. This has given us an opportunity to study the effects of cathartics upon the leucocytosis in these cases.

A former assistant, Dr. John L. Yates, has proven conclusively, by a large series of experiments upon animals, that infectious material is rapidly diffused by the administration of food or cathartics, because of the establishment of peristalsis. Injecting lampblack into the abdominal cavity, he found that this remained in a circumscribed location so long as the intestines were at rest; but upon the administration of cathartics it is rapidly diffused over the entire peritoneal cavity. The same was true of septic material introduced in the same manner.

Constipation is looked upon rightly as a cause of ill health; consequently it is but natural that, counting upon the law of probabilities, a physician or a layman who gives a cathartic in every case, with or without having previously made a diagnosis, will have fair results in most patients who are not suffering from peritonitis. Moreover, in cases in which there is not as yet a circumscribed peritonitis, especially in catarrhal appendicitis, the patient feels better after the use of a cathartic and, as there is no septic material present to be diffused throughout the peritoneal cavity, no harm can come to this class of patients.

If one can be absolutely certain, therefore, in any given case, that there is no circumscribed infection, a cathartic can, of course, be given safely in that case. If no harm comes from it, the diagnosis has been confirmed, but whenever there is the slightest doubt it would be foolish to take such a risk for the sake of confirming a diagnosis. As a general rule it may be stated that in all doubtful cases, even if the doubt be ever so slight, a cathartic should never be given because in the given case in which it is harmless it is not needed, as the bowels will be spontaneously evacuated, and in the other cases cathartics are contraindicated.

That a cathartic is safe in only a very small percentage of cases was proven by Murphy's statistics of 1895, which showed that in 94 per cent. of cases of acute appendicitis pus was found outside the appendix at the time they came under treatment. It is plain that the 6 per cent. in whom the infection is still confined to the appendix will all recover under proper surgical treatment, and the 94 per cent. in whom the infection is already beyond the tissues of the appendix must be exposed to great risk if peristalsis is caused by the administration of cathartics.

Effect of cathartics in cases of mechanical obstruction of the intestine. However harmful it may be to administer cathartics in cases suffering from circumscribed peritonitis, it is still more harmful to administer these remedies in cases suffering from mechanical obstruction of the intestines, no matter whether this be due to strangulated hernia, volvulus, Meckel's diverticulum, constricting bands of adhesion, intussusception, kinking of the intestines, impacted gallstone, impacted submucous lipoma or fibroma in the intestinal

wall or obstruction due to malignant growths in the intestinal wall or pressing upon it from the outside.

In every case in which there is even a suspicion of mechanical obstruction of the bowel, gastric lavage should be instituted at once and absolutely nothing should be given by mouth.

The intestine above the point of obstruction suffers so severely as a result of the pressure from the peristaltic action caused by cathartics that the walls become permeable to the passage of septic material, which is proven by the presence of micro-organisms in the peritoneal fluid, and the mortality is at least four times greater in cases that have received cathartics than in those that have received none. In many cases the intestine may even be perforated above the constriction as a result of the use of cathartics. All of these conditions we have encountered many times in practice.

Puerperal sepsis and post-operative sepsis must, of course, be eliminated by proper prophylaxis.

Although convinced that abstaining from the use of cathartics alone in cases of incipient peritonitis is the most important means of inhibiting this disease, still we believe that it is most important to bear in mind all of the following conclusions and that, when these have been thoroughly applied in practice, deaths from peritonitis will be almost entirely eliminated. These conclusions are quite as applicable to cases which are treated surgically as those treated without surgical intervention.

It would be most unfortunate if, by directing attention particularly to the harmful effects of cathartics in peritonitis, this section should lead especially the general practitioner to think that this is the only dangerous form of treatment, because the errors pointed out in the following conclusions have also destroyed an enormous number of human lives, and by constantly keeping them in mind any general practitioner can reduce his mortality decidedly.

Conclusions. 1. A careful physical examination should always be made in patients suffering from gastric disturbances, nausea, vomiting, gaseous distension or pain in any portion of the abdomen, so that an early diagnosis can be made. In acute cases violent manipulations are dangerous and not necessary during examination. They may cause a diffusion of septic material.

2. A diagnosis of chronic appendicitis, gastric or duodenal ulcer or gallstones should be made through a careful study of the history and physical examination, and relieved by proper treatment before a perforation is possible.

3. Patients suffering from intestinal obstruction, whether this be due to strangulated hernia, constriction by bands or adhesions, volvulus, intussusception or kinking of intestines, Meckel's diverticulum, gallstones or carcinoma, should be operated at once and they should never, under any circumstances, receive either cathartics or food by mouth after this condition is even suspected.

4. Gastric lavage should be employed in these cases at once and again immediately before operation, and it is well to leave the stomach tube, preferably the form invented by Kausch, in the stomach to drain out any intestinal fluid which may regurgitate during the operation. Many of these cases can be operated under local anesthesia.

5. Opium in any form should never be given before a diagnosis has been made, and never in the presence of any form of peritonitis, unless gastric lavage has been done, and the introduction of every form of nourishment and cathartics by mouth is absolutely prohibited. This applies to even the simplest forms of liquids, like beef tea or broth, and also to the use of champagne and other stimulants.

6. This applies quite to the same extent to post-operative treatment.

7. In military surgery it is most important as a prophylactic measure that soldiers enter the firing line with empty stomachs and intestines.

8. Abdominal wounds made during battle, with large objects like splinters from shells, indicate immediate operation.

9. Abdominal wounds inflicted in battle by small calibre bullets, in the absence of hemorrhage, should be treated by absolute rest; not even water should be given by mouth.

10. An exception should be made in cases which can be in the hands of the operating surgeon with satisfactory assistants and facilities within two hours after the injury. Under these conditions an immediate abdominal section is indicated.

11. Gastric lavage should be done at once in every patient suffering from any form of peritonitis, except from stomach or duodenal perforation, if nausea or vomiting or gaseous distension is present, no matter what other form of treatment may be contemplated.

12. No food of any kind whatever and no cathartics should ever be given by mouth in the presence of peritonitis, no matter what other form of treatment may be contemplated.

13. Even water by mouth should be prohibited until the patient is well on the way to recovery.

14. Instillation of normal salt solution by the drop method, by rectum, as introduced by Murphy, or by some other safe non-irritating method, is one of the most valuable means of inhibiting peritonitis. It is well to give normal salt solution continuously from one to two hours and then to interrupt this treatment for two hours.

15. In rare cases in which this method cannot be employed, normal salt solution should be given subcutaneously in quantities of 500 to 1,000 ccm. sufficiently often to overcome thirst and keep the blood vessels filled.

16. Large enemata, except by the drop method, should never be given in the presence of peritonitis.

17. In order to prevent post-operative peritonitis, it is important never to traumatize the intra-abdominal organs unnecessarily during operation.

18. Much less handling of the intestines is necessary if these are not distended with gas, a condition which can best be secured by giving the patient two ounces of castor oil on the day before the operation, but this should never be given in the presence of even the slightest amount of peritonitis in any form.

19. Gastric lavage following abdominal section often prevents incipient peritonitis from progressing by inhibiting peristalsis; it should always be employed in the presence of nausea or vomiting or gaseous distension. In order to prevent gagging, it is well to spray the pharynx thoroughly with a 2 per cent. solution of cocaine ten minutes before the stomach tube is introduced.

20. In acute appendicitis the appendix should be removed before the infection has extended beyond the organ. If conclusion No. 1 is adhered to, this can be done in almost every case with almost perfect safety, because the patient can then be placed in the hands of a competent surgeon within thirty-six or forty-eight hours from the beginning of the attack.

21. In subacute and chronic appendicitis the appendix should be removed before it has an opportunity to cause an acute attack.

22. In acute appendicitis which has been carried through an attack without an operation, it is well to confine the patient absolutely to a liquid diet until his appendix has been removed.

23. In cases of acute appendicitis, either perforative or gangrenous, which have received some form of food or cathartics after the beginning of the

attack, which reach the care of a surgeon too late for a safe early operation and are suffering from beginning diffuse peritonitis, gastric lavage, absolute abstinence from food and cathartics by mouth and the slow instillation of normal salt solution by rectum are indicated.

24. This will result in the increase of resistance against infection to such an extent that 97 per cent. of these cases of perforative or gangrenous appendicitis can later be operated with safety.

25. Feeding should be entirely by enemata, preferably consisting of one ounce of a commercial concentrated liquid food dissolved in three ounces of normal salt solution given slowly every three or four hours through a small rubber catheter introduced into the rectum not more than three inches.

26. From ten to thirty drops of deodorized tincture of opium should be added to each rectal feeding, until there is no longer any pain.

27. Placing these patients in the Fowler position greatly increases their safety.

28. The application to the abdomen of a large, hot, moist dressing of equal parts of a saturated solution of boric acid and alcohol greatly increases the comfort of these patients and prevents harm from manipulations.

29. It is important for the general practitioner and the general public to become familiar with the danger of giving any kind of nourishment or cathartics by mouth in the presence of impending peritonitis from any cause, and that this applies to milk, broth and other forms of liquids and even to water.

The repetitions in these conclusions are intentional because it has seemed worth while to cover every possible point so completely that no one taking the time to read these conclusions carefully could be in doubt. As stated before, these conclusions are all based upon the observation of a very large number of cases and they are not in any way theoretical, as they all have an intensely practical foundation.

TUBERCULOUS PERITONITIS

Typical case. The patient is a married women thirty-two years of age, giving the following history:

Her father died of pulmonary tuberculosis at the age of fifty. One sister died from the same cause at the age of thirty. Another sister is suffering from the same disease at the present time. The patient had measles as a child but otherwise has had good health. Her menstruation began at the age of fifteen and was regular but somewhat painful. She married at twenty-two; has had five normal pregnancies. She has suffered from constipation during the past ten years. The abdomen has been distended for several years and she has suffered from eructations of gas. About four months ago fluid was first discovered in the abdominal cavity. She was then put to bed and received internal treatment, but the accumulation of fluid in the peritoneal cavity has constantly increased. In the meantime she has lost ten pounds in weight. She has occasional pains in the left side of the abdomen, lasting a few hours at a time. The abdomen is enlarged to the size of a six months' pregnancy, but is flattened and there is a prominence of the umbilicus.

The patient is sufficiently nourished; her tongue is clean; the appetite fair; bowels constipated; heart, lungs, liver and kidneys normal; her temperature is normal; pulse is 80, regular and fairly strong; abdomen is distended and tympanitic above. A hard mass is felt in the right side of the abdomen opposite, and a little below, the umbilicus; slightly movable, but does not move with respirations. Her right kidney is movable. There is dullness upon percussion, with the exception of a small area over the most prominent part of the abdomen. The area of dullness changes with a change in her position. Upon vaginal examination the uterus is found bound down by a solid mass in the pelvis.

This history, together with the physical examination, would indicate the presence of a tuberculous peritonitis with fluid in the free peritoneal cavity. The fact that the heart, liver and kidneys are normal would indicate that the fluid contained in the peritoneal cavity must be the result of a local irritation.

This might be due to the presence of a papilloma originating from the ovary, but that would scarcely account for the mass in the upper portion of the peritoneal cavity, which is probably the result of adhesions between the omentum and the intestines, due to abdominal peritonitis. It is not difficult in this case to differentiate between this condition and the presence of an ovarian cyst, because the abdominal cavity is not so thoroughly distended as to make all portions dull upon percussion, nor are the small intestines so completely agglutinated by tuberculous peritonitis as to be held away from the circumscribed accumulation of ascitic fluid, making a resonant area above or to the side. The tubercular family history would make a tubercular infection especially likely, although many of these cases obtain their infection from food. Most of these patients have at least a little elevation of temperature in the afternoon or evening, or a subnormal temperature in the morning, and if careful record of this patient's temperature had been taken throughout her period of sickness, we are confident that this condition would have been found at some time. Even at the present such a variation in temperature could undoubtedly be established within a week or two by taking the temperature regularly.

The diagnosis can be confirmed by using the tuberculin test or by applying the test introduced by Von Pirquet, but in cases as clear as this one these additional tests are not necessary. The latter is absolutely harmless, hence there is no reason why it should not be used in every instance. The tuberculin test when cautiously applied so rarely does harm that in the event of doubt, it is always well to employ it, as it is somewhat more reliable than the other.

Treatment. This patient has been under constant treatment during the past four months by a careful and competent physician. The treatment consisted of hygienic measures, of rest in bed, of intestinal antiseptics, and she has been given good, wholesome food, care being exercised that the milk, and all the other food which might possibly contain tubercle bacilli, was carefully sterilized before use.

An incision three inches in length is made in the linea alba below the umbilicus. This at once permits a large quantity of thin, slightly-yellowish fluid to escape, leaving the peritoneal cavity studded with tubercles throughout, the intestines and omentum being somewhat adherent in the upper portion of the peritoneal cavity; the cecum and appendix to the right being covered with the same small tubercles, the uterus, ovaries and tubes, and the sigmoid flexure, forming a mass in the pelvis also covered with tubercles. The peritoneum is one-eighth of an inch in thickness, somewhat purplish in color and completely studded with tubercles.

After carefully sponging away all of the free fluid with moist aseptic gauze pads, exercising great care not to cause any abrasions by the manipulations, a large glass drainage tube covered with four thicknesses of formidin gauze is placed in the cul de sac and permitted to project through the lower angle of the wound, then the abdominal wound is closed.

It is doubtful whether in a patient like this it is better to close the abdominal cavity at once or to insert a drainage tube surrounded with iodoform gauze, as previously described. In case the latter method is chosen the tube and gauze should be removed as soon as the drainage has ceased.

In following the experience of a number of surgeons who invariably drain these cases, and others who close the abdominal cavity without drainage, it has seemed that the former have much fewer recurrences than the latter. This has also been our personal experience, so that we now drain invariably in all cases in which we operate for the relief of tuberculous peritonitis.

Medical vs. surgical treatment. At the present moment the treatment of tubercular peritonitis seems to drift back into the hands of the practitioner

of internal medicine, after having been virtually considered a surgical disease. Until very recently, and for a period of more than ten years, surgeons were generally willing to undertake the surgical treatment, and their immediate results were usually so favorable that it seemed as though the surgical treatment had become permanently established. Recent literature, however, indicates that surgeons with a considerable experience report approximately fifty per cent. of recoveries extending over at least two years. Those who report fewer cases show a larger percentage of recoveries, but it is scarcely fair to count these cases, because it is likely that in this group a greater proportion of favorable than unfavorable instances are reported, i. e., of all surgeons who have operated upon only one or two of these cases those who have been fortunate in their results will feel inclined to encourage others, while those who have been unfortunate abandon the subject as unworthy of special attention.

Drainage, irrigation and medication of the abdominal cavity are not only considered useless by many writers of great experience, but actually undesirable, and the simpler the operation performed the better will be the result according to these authorities. This idea is illustrated in many of the instances that were found to suffer from tubercular peritonitis when the operation had been performed with the expectation of removing an ovarian cyst, the fluid drained and the abdominal wound either drained or closed. In many such cases the condition appeared absolutely hopeless and it seemed to be foolish to do anything at all.

A very large number of similar cases have been reported by different authors and the literature contains many interesting compilations of cases which appear to show great benefit from abdominal section. During the past few years it has been shown that the results in cases treated for tubercular peritonitis in the medical departments of many of the great hospitals were about the same as those in the surgical clinics. If these observations are correct it would appear as though these patients should be placed under medical rather than surgical treatment, because the latter is, of course, connected with a greater amount of pain and a slight amount of danger from the operation itself. That many cases have recovered permanently and completely after abdominal section there can be no doubt, because this has been positively proven by autopsies upon patients who died from other causes, when they were found completely cured, tuberculosis having been demonstrated at the operation and the diagnosis confirmed microscopically.

Many of these patients have later been operated for other conditions and the peritoneum has been found so entirely free from evidences of tuberculosis that it seemed impossible to imagine it to be the same peritoneum. We have made this observation in a number of our own patients.

Although the diagnosis cannot be made so positively in those treated without operation, it seems clear that many undoubted cases have been cured by medical and hygienic measures. Since the introduction of the tuberculin and Von Pirquet's tests a positive diagnosis can be made even in cases not operated, hence statistics in the future will, of course, be more acceptable.

An analysis of the various papers on both sides of this controversy shows, it seems, that the authors were not discussing the same class of patients.

Medical treatment generally instituted early. The medical practitioners seem to deal with these cases earlier in the attack, while the condition is still more or less acute; on the other hand, surgeons meet with the cases in the chronic condition after those which are curable by medical treatment have been eliminated. In other words, the medical treatment is virtually applied to all cases at first, and if persisted in will result in approximately fifty per cent. of cures, of which about one-half have a recurrence after a number of years. If the medical treatment in the remaining fifty per cent. of cases is

continued after the time when it becomes apparent that it has no beneficial effect, then the chances are that such cases will go from bad to worse until they succumb. If, however, surgical treatment is employed in these cases in which medical treatment has proven to be of no benefit, then all of the cases of this group which recover permanently, as well as those which are temporarily improved, constitute an absolute gain, because they reduce the failures from the internal treatment and increase the favorable results by their entire number.

It is interesting to note that all authors who favor the medical treatment of these cases insist upon beginning during the early part of the attack, in fact, as soon as the diagnosis has been made. They all advise primarily hygienic measures; rest in bed, intestinal antiseptics, some form of creosote, and some form of iodine to be given internally; also sterilized, concentrated food and living and sleeping in the open air.

Many external applications have been advised, especially ointments containing some form of iodine or mercury. Those advising surgical treatment combine hygienic treatment with it and advise that this be continued indefinitely after the recovery from the operation.

Of those who advise operative treatment several surgeons of large experience caution against operation too early in the attack, because recurrence is more likely in case the operation is performed before the tubercles are fully developed. It has been demonstrated experimentally that this is a wise precaution to take, because new tubercles developed in animals after an early laparotomy, while in other similar animals a later operation has resulted in a permanent cure. The cure is attributed to the secretion of an antitoxin which, it is claimed, is not produced before the tubercles have been fully developed.

Many experiments have been made to determine the manner in which the cure is accomplished. It has been demonstrated in animals, upon which an artificial tubercular peritonitis had been produced, that the abdominal section is followed by a severe hyperemia which lasts longer than in cases not suffering from tubercular peritonitis. This is considered the curative element which is attributed to the action of the air upon the diseased peritoneum, as it does not occur when the animals are kept submerged in normal salt solution during the operation. Other authors have attributed the curative effect of abdominal section to an antitoxin produced from the dead bacilli, which will be absorbed. These conclusions are also based upon experimental research. It has been found that the antitoxic effect of the ascitic fluid increases with its age.

Our experience in the treatment of tuberculous peritonitis in patients who belong to a class in whom dietetic, hygienic, and medicinal treatment had been carefully carried out for a considerable period of time before surgical intervention was determined upon, now covers a very large number of cases. Many of these we have followed for years after they left the hospital. In the former editions of this book we tabulated thirty-two cases operated between 1892 and 1902. Space does not permit the tabulation of all of the cases that we have operated during the fifteen years which have passed since that time, but it seems proper to give our conclusions, which are based upon a study of the literature which has appeared since that time, and upon our personal experience.

Conclusions. 1st. Patients suffering from tubercular peritonitis should first be subjected to careful medical, dietetic and hygienic treatment.

2nd. This treatment should consist in the use of intestinal antiseptics, anti-tubercular remedies and rest in bed. Sterilized food and improved hygienic conditions generally should be employed. The vaccine treatment should be carefully tried in these cases. X-ray treatment should also be tried.

3rd. So long as the patient's condition improves reasonably this treatment should be continued.

4th. In case the patient's condition does not improve, or becomes worse, abdominal section is indicated.

5th. If the disease is confined to a part which can be safely removed without injuring any portion of the tuberculous peritoneum this should be done, provided the surface can be covered with healthy peritoneum.

6th. If the removal of any infected portion necessitates the severing of the tuberculous peritoneum or leaving a portion of the peritoneal surface denuded, the diseased tissue must not be disturbed.

7th. In case there is fluid in the peritoneal cavity, it is doubtful whether it is best to remove any tuberculous tissue, even though it be circumscribed.

8th. Enormous quantities of the tuberculous material can be absorbed from the peritoneal cavity after simple laparotomy.

9th. It is best to avoid all manipulation of the intra-abdominal organs during the operation, in case there is a diffuse tuberculous infection, and to confine the operation to simply opening the peritoneal cavity, permitting the fluid to drain out, admitting air to the peritoneal cavity, draining the cavity with a glass tube covered with gauze and closing the abdominal wound.

10th. Peritoneal adhesions should never be disturbed in patients suffering from tubercular peritonitis with ascites for fear of causing intestinal fistulæ.

11th. During the time of recovery from the surgical operation, and for a considerable period of time after this, the patient should be treated medically and with carefully regulated X-ray.

12th. The hygienic conditions of the patient must be permanently improved and he must not be permitted to expose himself to the influences which primarily caused the tuberculous infection.

13th. Permanency of cure is much more likely in patients who are not predisposed to pulmonary tuberculosis.

14th. Chronic cases with fluid, particularly if encapsulated, and not benefited by medical and hygienic measures, are especially amenable to surgical treatment.

15th. Repeated operations are indicated in case of re-accumulation of fluid.

16th. It is important to regulate the hygiene and diet of these patients permanently after they have recovered from this disease.

17th. It is especially important to locate the source of the primary infection and to make reinfection from this source impossible.

18th. If possible they should change their residence sufficiently to insure satisfactory hygienic conditions.

19th. All milk and all meats should be sufficiently cooked to prevent reinfection from these sources.

20th. In employing the vaccine treatment it is of the greatest importance to use a very small dosage, a good rule being to administer one-half of the smallest dose that will cause the slightest reaction.

During the past years we have found the use of intensive X-ray treatment of great benefit in these cases. We have given an intensive X-ray treatment over the location of the peritonitis each day for six successive days, then we have interrupted this for some three to four weeks, when we have repeated the treatment. Even after the first treatment there is usually a marked permanent improvement, which is increased after each one of the successive treatments Of course, general hygiene and diet, out-of-door sleeping, and rest in bed as long as there is any temperature, must be continued notwithstanding this addition to our plan of treatment.

GENERAL CONSIDERATIONS IN BOWEL SURGERY

The greatest number of operations upon the intestines are performed for the relief of mechanical obstruction. This may be due to strangulation, as in strangulated hernia, or constriction due to a cicatricial band or an adherent Meckel's diverticulum, or an adherent appendix or a volvulus. Again operation may be needful for the relief of obstruction due to a foreign body in the alimentary canal, such as a gall-stone or an enterolith, or to a malignant growth occluding the lumen of the intestine or to an intussusception.

General principles in bowel surgery. There are a few general principles which should be borne in mind in all surgical work upon the intestine, viz.:

1. The circulation should be as perfect as possible at the point of operation. There is always great danger of interfering with the blood supply when sutures or ligatures are applied in the vicinity of the omentum or the mesentery.
2. Care should be taken never to apply stitches or ligatures to the omentum near its attachment to the colon, because this is frequently followed by gangrene.
3. In all operations it is important to apply the sutures so that the two layers of the mesentery are held together, because the space between these layers is not covered with peritoneum and is consequently deprived of nutrition if this precaution be not taken. When an end-to-end anastomosis is made in the small intestine this danger can be still further guarded against by placing the ends so that the mesentery does not come directly in apposition in the two segments, twisting one segment a few degrees to the right and the other a few degrees to the left, so that there is a distance of about one-eighth of the circumference of the intestine between the mesenteric attachments of the two segments.
4. The same principle applies to the choice of location and form of the anastomosis. It is always safer to make an anastomosis where it is possible to unite surfaces which are covered with peritoneum, hence in many instances a side-to-side, or an end-to-side anastomosis is to be preferred to an end-to-end junction.
5. Tension should always be avoided.
6. The omentum can be utilized to enforce an anastomosis by supplying nutrition from its rich circulation.
7. When an anastomosis or enterorrhaphy is performed after removing a portion of gangrenous intestine the proximal segment is likely to cause leakage unless the enterorrhaphy is made a considerable distance above the portion of intestine that was gangrenous.
8. In case of tumors of the mesentery it is wise to make an anastomosis which will permit the passage of intestinal contents above the point at which the nutrition has been impaired by the removal of a mesenteric tumor.
9. Care must be taken to prevent angulation, which will result later in obstruction.
10. Allowance must be made for shrinkage of the anastomosis openings, due to cicatricial constriction.
11. Care must be used to prevent free spaces underneath intestines through which herniæ may occur later.
12. Raw surfaces should never be left in intestinal operations because adhesions are especially bad in these cases.

EXCISION OF THE CECUM

Typical history. The patient is a farmer fifty-six years of age who gives the following history: Family and previous history negative. Has enjoyed good health and has been able to work hard until a few months ago. The only discomfort he has experienced has been

from chronic constipation which has existed for many years, but which has alternated during the past year with acute attacks of "dysentery" which have lasted but a day or two at a time. He has suffered from indigestion and from gaseous distension of the abdomen. The latter condition has become worse constantly during the past few months. In the meantime the patient has lost forty pounds in weight, his appetite having constantly become more and more impaired, and during the past few weeks he has frequently experienced a feeling of nausea.

He is a somewhat emaciated, slightly cachectic man, skin dry, very slightly jaundiced, tongue coated, appetite poor, severely constipated, heart, lungs and kidneys normal, temperature slightly sub-normal. Abdomen thin-walled, soft, slightly distended, peristalsis of small intestines can be seen on surface of the abdomen. At a point half-way between the end of the twelfth rib and the anterior superior spine of the ilium a hard, oval, slightly lobulated mass apparently four inches in length and two inches in diameter can be felt through the abdominal wall. It is slightly movable and not especially painful upon manipulation. It seems to be attached posteriorly. Upon inflation of the colon by means of a pump attached to a rectal tube the tumor is not displaced and the gas does not distend the colon in front of it. The distension seems to extend to a point directly above the beginning of the tumor.

Diagnosis. A careful review of this history must direct our attention to the existence of partial obstruction of the alimentary canal, which is increasing in character and has of late become almost complete, as indicated by the frequent feeling of nausea.

The location of the tumor corresponds to the cecum or the ascending colon. Its sessile nature would indicate the same organ. The fact that it is not disturbed by the inflation of the colon would eliminate the kidney and the gall bladder. The fact that continued treatment with cathartics does not affect the size or form of this tumor would eliminate fecal impaction. The age of the patient and the cachexia would point toward malignancy. We will consequently make a diagnosis of carcinoma of the cecum or the ascending colon, or both.

Indications for treatment. There has been a constant increase in the obstruction, hence it is to be expected that a complete interference must occur soon. In order to avoid this some radical measure must be instituted. Moreover, this should be undertaken before the patient's strength has declined still more. We shall consequently advise an operation as soon as the patient has received the necessary preparation.

Complete intestinal obstruction might occur in this case at any time by the occlusion of the slight remaining opening in this intestine with some small mass of undigested food. A small piece of meat fiber or an orange seed, and in a number of cases an enterolith, has been observed to cause a complete obstruction. In case this occurs the condition becomes exceedingly grave at once, because the same symptoms will arise which characterize acute mechanical obstruction of the intestine, namely, pain, sudden gaseous distension of the abdomen, nausea, vomiting and shock. Patients quite advanced in age and greatly reduced by long-continued disease do not bear this condition well.

The question of an immediate operation. The question consequently arises as to the advisability of an immediate operation when a complete obstruction has occurred. Should the patient come under treatment at once the immediate operation is undoubtedly indicated, because the intestines are still in a good condition and the patient has not lost much strength. It has, however, been our experience that these patients have become accustomed to the use of strong cathartics and that consequently they are likely to employ such means for several days before consulting a physician, changing from one to the other drug until they are completely exhausted. In such examples we have found that an immediate operation is usually followed by the speedy death of the patient, because his strength has been greatly impaired and great pressure has been brought to bear upon the badly nourished intestinal walls above the point of obstruction from the constant

use of strong cathartics. The intestines are distended, making an operation extremely tedious. This distension is accompanied by a greater permeability of the walls to the passage of micro-organisms, hence an infection is favored in this manner. It usually becomes necessary to open the intestine and to permit its contents to escape before the bowels can be replaced in the abdominal cavity. This evacuation should be accomplished through a large glass tube, to be described presently, through which the intestine should be thoroughly irrigated with normal salt solution at 105° to 110° F. The administration of cathartics after complete obstruction has occurred accounts for the extremely high death rate in cases operated upon under these conditions.

For a number of years we have consequently followed another plan and have found it far safer for the patient. Many cases brought to the hospital in an apparently hopeless state have improved from day to day and were presently carried to a point at which it was possible to perform the necessary operation safely. Of course there are cases which are moribund at the time of admission to the hospital and these will die, usually within a few hours after admission, no matter whether or not they are operated.

Conservative treatment. The treatment that has been followed by the greatest percentage of recoveries in our experience has consisted in reducing the pressure, as much as possible, above the point of constriction. This can be accomplished best by performing gastric lavage several times, at intervals of a few hours, under cocain anesthesia of the pharynx. There is usually a regurgitation of decomposing material into the stomach, which will be removed by the gastric lavage. In this manner the stomach, and the intestine above the obstruction, soon become emptied of decomposing material and gas. The distension disappears gradually, the intestinal walls seem to regain their power of contraction, the absorption of products of decomposition ceases and the patient's condition improves practically in all cases in which the intestines still contain a sufficient amount of tone to force their contents back into the stomach by return peristalsis.

The emptying of the intestines above the point of obstruction can be further facilitated by elevating the foot of the bed, which favors the flow of intestinal contents back into the stomach where the accumulation will be indicated by the presence of nausea, which is again relieved by gastric lavage. The precaution is of importance moreover because it will protect the patient against drowning in his own vomit, an accident which we have observed several times.

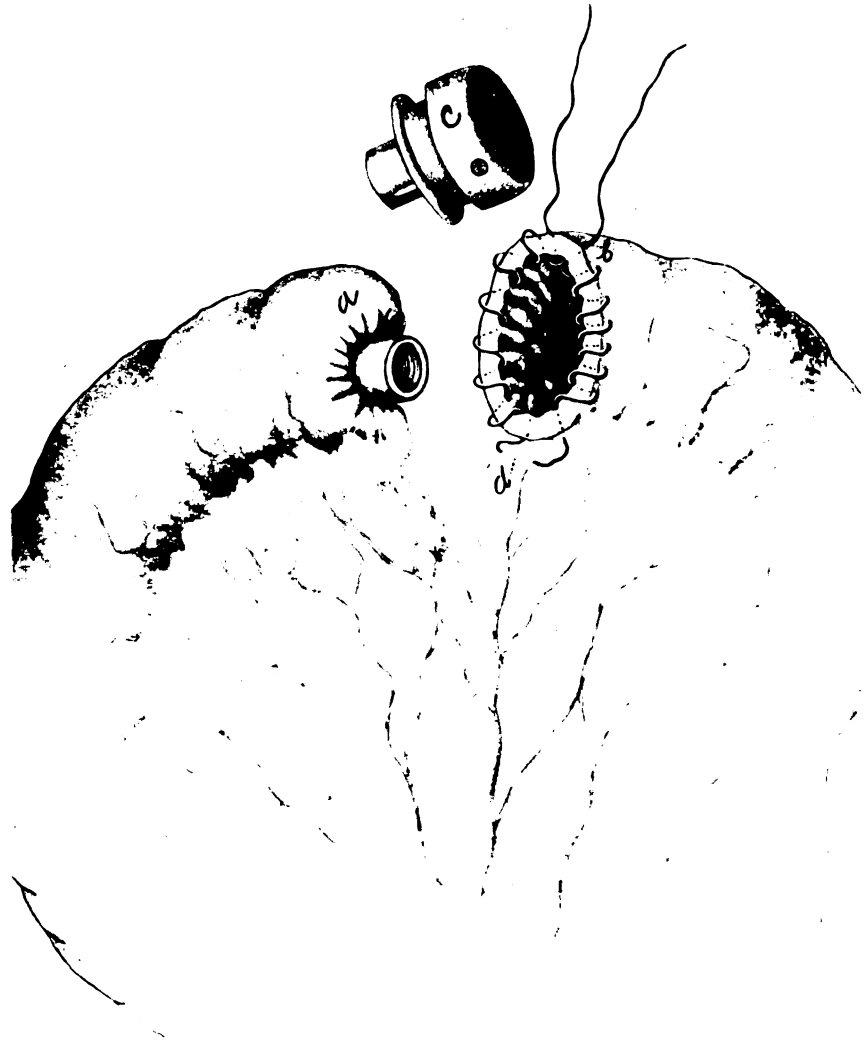
In case the obstruction is due to the wedging of a fine substance into a constriction caused by the presence of a carcinoma in the colon the method named of relieving the pressure from above may result in its dislodgment.

Maury has shown that patients with intestinal obstruction are severely poisoned by a secretion from the mucous lining of the duodenum, which explains why many of them recover so splendidly after repeated gastric lavages, because this poisonous substance is regurgitated into the stomach and washed away by the lavage.

In the meantime the patient is supported by the use of nutrient enemata, one ounce of liquid predigested food being dissolved in three ounces of normal salt solution and administered through a soft catheter inserted into the rectum a distance of about two inches. This should be repeated once in four hours. If the patient suffers from thirst half a pint of normal salt solution may be given as an enema in the same manner every hour until the thirst has subsided. It is important not to introduce the catheter a greater distance than about two inches because otherwise one frequently observes severe irritation.

This treatment can usually be continued with benefit and with safety for

a number of weeks. In many cases the absence of irritation and pressure from above will result in the passage of gas and liquid feces through the stricture, because there is always a certain amount of edema which subsides when the irritation has disappeared.



INTESTINAL ANASTOMOSIS.

End-to-end with Murphy button; (a) button in place with purse-string suture tried: (b) end of intestine with suture in place, showing manner of including mesentery at (d); a mesenteric vessel is represented as tied at a point a little below and to the left of (d); (c) represents the remaining half of the button to be introduced into the segment (b).

It is best not to give any food by mouth to these patients, after the obstruction has once been complete, until the hindrance has been removed. Should it seem necessary to postpone the operation for a time it is best to continue the use of the nutrient enemata and to give only such nourishment

by mouth as will be completely absorbed from the stomach and small intestines.

After this condition of relief has been attained in cases of complete intestinal obstruction due to the presence of carcinoma in the colon, the treatment will be the same as in those in which the obstruction is not complete. In cases in which the stricture *remains impermeable,* the operation for the relief of the obstruction will have to be carried out at a time which seems favorable in the judgment of the surgeon who has the case under observation. In these cases there can, of course, be no further preparatory treatment.

Preparatory treatment. In all operations upon the alimentary canal except in the presence of intestinal obstruction or peritonitis, it is well first to remove, so far as possible, all of the contents thereof by the administration of cathartics and large enemata and then keeping the patient on sterilized food entirely until the time of the operation. It is well to repeat the cathartics once or twice, if the patient's condition warrants it, in order to remove as much as possible all infectious material from the alimentary canal. Two ounces of castor oil, given in the foam of beer, ale or malt extract, is usually most effective and gives rise to the least amount of irritation.

Especial stress should be laid upon the value of castor oil used in the manner indicated above. From time to time we have tried other cathartics but have become absolutely convinced of the fact that none of them serves the purpose of removing septic material from the alimentary canal so perfectly as this remedy when given in this dose and vehicle. It is tasteless, non-irritating, rarely produces nausea or vomiting and the results are ideal.

In cases in which there is but a small opening left, but which is still permeable, we often give two ounces of castor oil once or twice daily for several days before the operation, followed by the administration of large normal salt solution flushings of the lower bowl. This clears up the patient's general appearance greatly, as they have usually absorbed fecal material lodged above the seat of obstruction for months before coming under our care. Of course it is of importance in the meantime not to give food which will favor further accumulation.

The patient may chew tender broiled steak and swallow the juice, but not the pulp, or take egg albumen, broth, fruit juices and milk with lime water or with milk of magnesia.

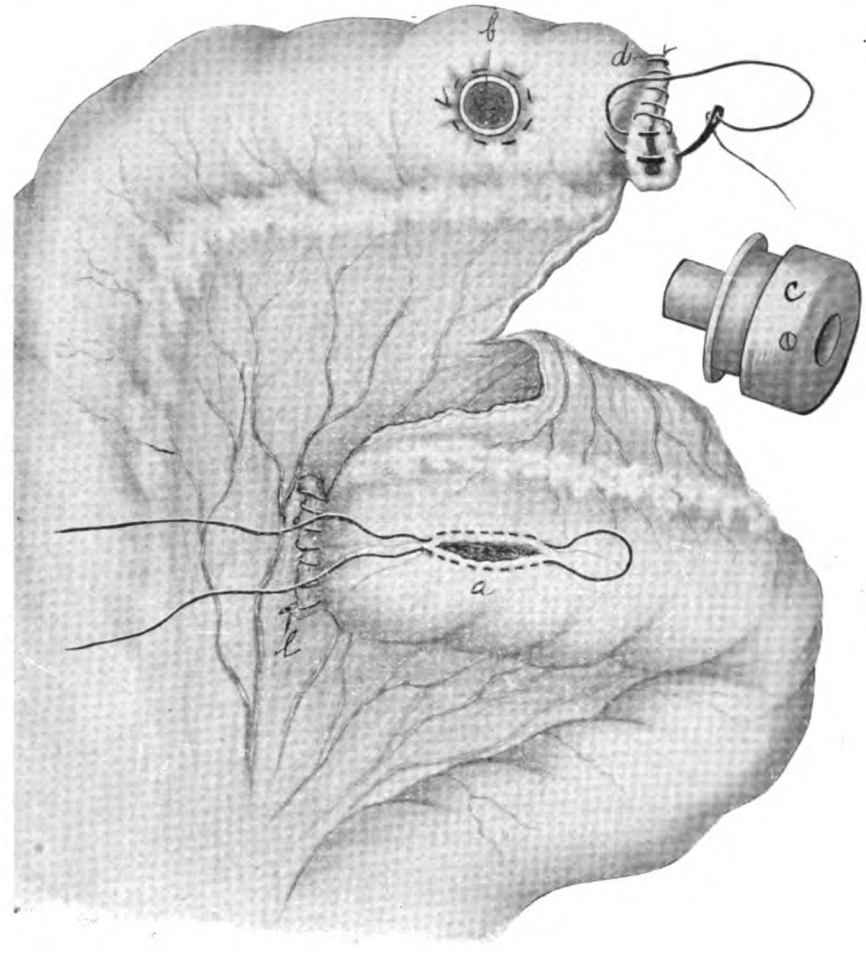
The field of operation is prepared in the usual way.

Technique of operation. In this patient the tumor can be located definitely, consequently the incision will be made in a position facilitating its removal. It is not possible to determine the exact length of incision that may be required for the removal of this tumor, hence we must choose a location for the incision which will permit of its enlargement. We will choose the outer edge of the right rectus abdominis muscle. This may be lengthened indefinitely if it should seem desirable during the process of the operation.

We find a tumor in the cecum and ascending colon beginning a little above the entrance of the ileum into the cecum. The tumor is about twelve cm. in length and involves the entire circumference of the intestine. It is exceedingly hard, but apparently has not perforated the wall of the bowel at any point. It seems as though the entire growth were still confined to the intestine and consequently its removal may result in a permanent cure. At any rate it is certainly worth the effort to attempt securing such a result.

It will be necessary to remove the entire ascending colon together with the cecum. We must consequently plan to secure a union between the ileum and the transverse colon. We will first tear an opening through the mesen-

tery of the ileum, an inch from its entrance into the cecum. A strong, long-jawed hemostatic clamp is applied to the ileum on the side toward the cecum. A circular, purse-string suture is then applied, either before or after sever-



LATERAL ANASTOMOSIS OF INTESTINES WITH MURPHY BUTTON.

This plate does not show the end of the intestine properly; the tissue should be represented as inverted into the lumen of the intestine by means of Lembert sutures at (d) and (e). At (a) the purse-string suture is represented as applied properly, with the stitches near the edge of the incision. At (b) the segment of the button is in place and the purse-string suture has been tied. It is better to introduce the button through the open end of the intestine and to make a very small puncture of the wall, just sufficient for the central portion of the button to protrude, then to close the ends of the intestine. It will then not be necessary to apply the purse-string sutures at (a) and (b).

In uniting small intestine with small intestine the end-to-end anastomosis with the Murphy button is to be preferred to the end-to-side or side-to-side anastomosis. In uniting small intestine with colon an end-to-side anastomosis with the Murphy button seems most satisfactory. In uniting colon with colon a lateral anastomosis with needle and thread or with the McGraw ligature seems to give the most satisfactory results.

ing the intestine. If the intestine is severed before the suture is applied we prefer to insert the latter after the method illustrated in the plate, because this insures the holding together of the two layers of the mesentery, as well as

inclusion in the bite of the Murphy button of a uniform amount of each layer of the intestinal wall.

Before severing the intestine an assistant should grasp it, at a distance of about six inches from the cecum, between his thumb and finger to prevent the leakage of contents while the button is put in place. The same result may be accomplished by perforating the mesentery between the large vessels, which can readily be recognized, and tying a strand of aseptic gauze around the intestine just sufficiently firm to prevent leakage. It is well to draw a snug-fitting pledget of moist, aseptic cotton through the button to prevent leakage after it has been tied into the end of the intestine and before it has been united with its fellow. The smaller portion of the button should be employed in this end of the intestine. The button is inserted and the purse-string suture is tied snugly about the projecting central tube of the button and the ends are cut short. Now this end is laid aside and covered with a warm, moist pad of aseptic gauze.

The cecum is now lifted out of the abdominal wound by means of the large clamp-forceps upon the small portion of ileum which has remained attached to the cecum. The peritoneum, together with its blood vessels, is now grasped in hemostatic forceps, both to the inner and outer side of the cecum. Then the portion between is cut away with scissors. In this way the cecum and the ascending colon can be freed rapidly.

As the operation approaches the hepatic flexure of the colon it is important to proceed cautiously for fear of clamping the duodenum, together with the peritoneum by which the ascending colon it attached. In this manner the hemorrhage can be controlled perfectly and the excision made rapidly. Having reached the hepatic flexure of the colon we are at least eight cm. beyond the tumor. We now apply two pairs of heavy, long-jawed, hemostatic clamps transversely across the colon and cut away the tumor by severing the intestine between. This will prevent any leakage from either end of the intestine. All of the vessels which have been clamped are now carefully ligated with catgut. At any point at which there seems to be danger of the ligature slipping off it is best to place a catgut suture about the part included in the grasp of the hemostatic forceps.

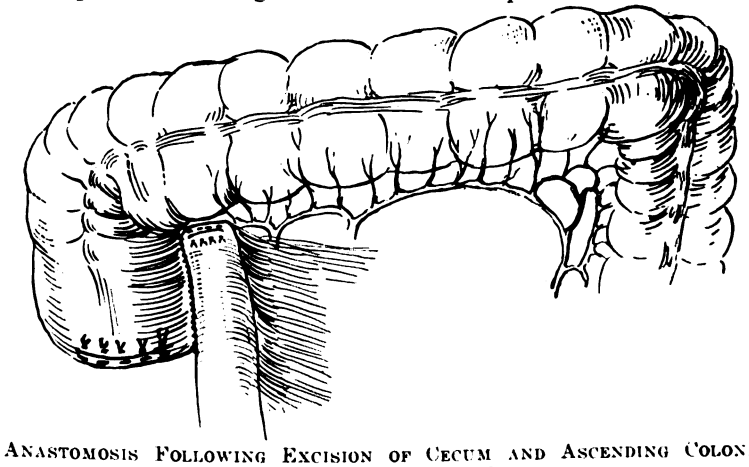
It is well to bear in mind the fact that the vessels contained in the mesentery have a tendency to retract, and that for this reason it is important to exercise great care in their ligation. The suggestion made by W. J. Mayo to split the peritoneum along the inner side of the intestine, expose the vessels, clamp and ligate them, is a very good one, especially when the mesentery is not definite in its development, because in this way every possibility of hemorrhage due to slipping of stump or retraction of vessels is avoided.

After perfect hemostasis has been attained a suture is applied to the surface of the transverse colon four inches from its end, as shown in accompanying plate. Care should be taken to have the ascending and descending thread in this suture not more than one-eighth of an inch apart. The intestine is now held between the finger and thumb of an assistant six inches beyond this point. Its end is enveloped in a pad of moist, aseptic gauze. The clamp which had up to the present time closed the cut lumen of the colon is removed. Any bleeding points are caught with hemostatic forceps and ligated. A short cut, see plate, a, is now made through the wall of the colon, half-way between the two threads of the suture. The Murphy button is carried into the lumen of the intestine and its central projecting tube is carried out through the incision just made. The ligature is tied to hold the button firmly in place, although this is scarcely necessary, because the opening is just large enough for the central projecting tube of the button to protrude. The open end of the colon is now closed by two rows of continuous sutures of fine silk,

the first row grasping all the layers and the second row of Lembert sutures serving to invert the first row into the lumen of the colon. The pledgets of cotton occluding the central tube of the button are now removed and the two segments of the button are united.

This completes the anastomosis. After carefully sponging off the surfaces and covering the defect in the peritoneum, caused by the removal of the cecum and ascending colon, with surrounding peritoneum, by means of a few catgut stitches, the abdominal wall is closed in the usual way.

In case the obstruction has been complete before the operation, so that the patient is so greatly reduced in strength that it seems unwise to expose him to a prolonged operation, it is best to make the anastomosis between the ileum and the colon at the first operation, in order to re-establish a satisfactory communication and then to make the excision of carcinomatous intestine after the patient's strength has been built up.



LATERAL ANASTOMOSIS FOLLOWING EXCISION OF CECUM AND ASCENDING COLON, BETWEEN LOWER ILEUM AND HEPATIC FLEXURE.
(Mayo.)

Resection of cecum. Two precautions seem to be important in connection with the excision of the cecum and implantation of the ileum within the colon.

(1) It is important to overcome the gas pressure in the colon by making a thorough dilatation of the sphincter ani muscle after the operation has been completed.

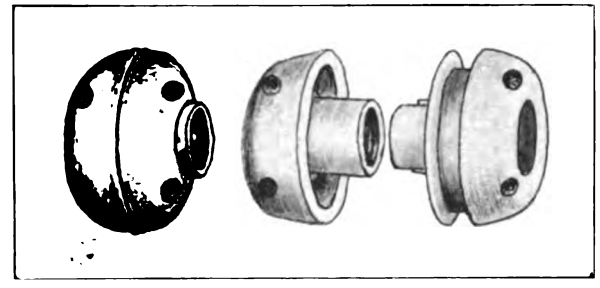
(2) Reder has suggested the wisdom of adding a temporary colostomy to this operation in order to prevent gas pressure and in order to enable the surgeon to introduce normal salt solution into the colon after the operation, which greatly increases the comfort of the patient and at the same time decreases the shock to a marked extent. A Jacobs retention catheter can be placed in this opening at the time of the operation, which will facilitate the introduction of normal salt solution. The opening can later be closed by destroying the mucous lining with actual cautery.

The suture method. We have given so far the method which we used exclusively until a number of years ago because it was, in our hands, most satisfactory. Since that time we have, however, discarded all mechanical means for securing union between any parts of the gastro-intestinal canal, not because the ingenious Murphy button was unsatisfactory in this especial operation, but because we have used the suture method thousands of times, especially in gastro-enterostomies, and have consequently acquired the habit of doing intestinal work by the suture method rapidly and satisfactorily.

For those without much practice in gastric or intestinal surgery we believe that the above method is still the easiest for the surgeon and the safest for the patient, and that in this operation and in end-to-end enterorrhaphy we have the only two operations in which it is proper to use the Murphy button at the present time. In all other operations upon the gastro-intestinal tract the suture method should be used exclusively. The Murphy button must always remain, however, an illustration of the possibilities of surgical ingenuity of the highest order.

The Murphy button. We have tested the usefulness of this appliance in a large number of these operations, and have found that it is most satisfactory if applied properly. The important points to be borne in mind in its use are:

1. The button must be well made and must be kept open while not in use, in order to prevent injury to the spring.
2. The silk suture must grasp all of the layers of the stomach or intestine, but it must be applied very near the edge of the incision in order not to draw too much tissue into the bite of the button.



MURPHY BUTTON.

3. The incision through which the button is passed must not be too large, just large enough for the button to pass through.
4. The purse-string suture holding the button must be tied very tightly and the ends cut short, and it is best to arrange the position of the knot so that the knots in the two segments do not meet.
5. If there is any projection of mucous membrane after the purse-string suture has been tied, this should be cut away before the two segments have been united.
6. When the two segments have been united there should be a perfectly smooth union throughout. If there is any projecting tissue it should be pressed in between the segments of the button by means of a spatula or the flat handle of a scalpel.
7. No sutures should be applied over the button.
8. The button must be placed in healthy tissue, never in the near vicinity of an ulcer or portion of the intestine which is in danger of becoming gangrenous.

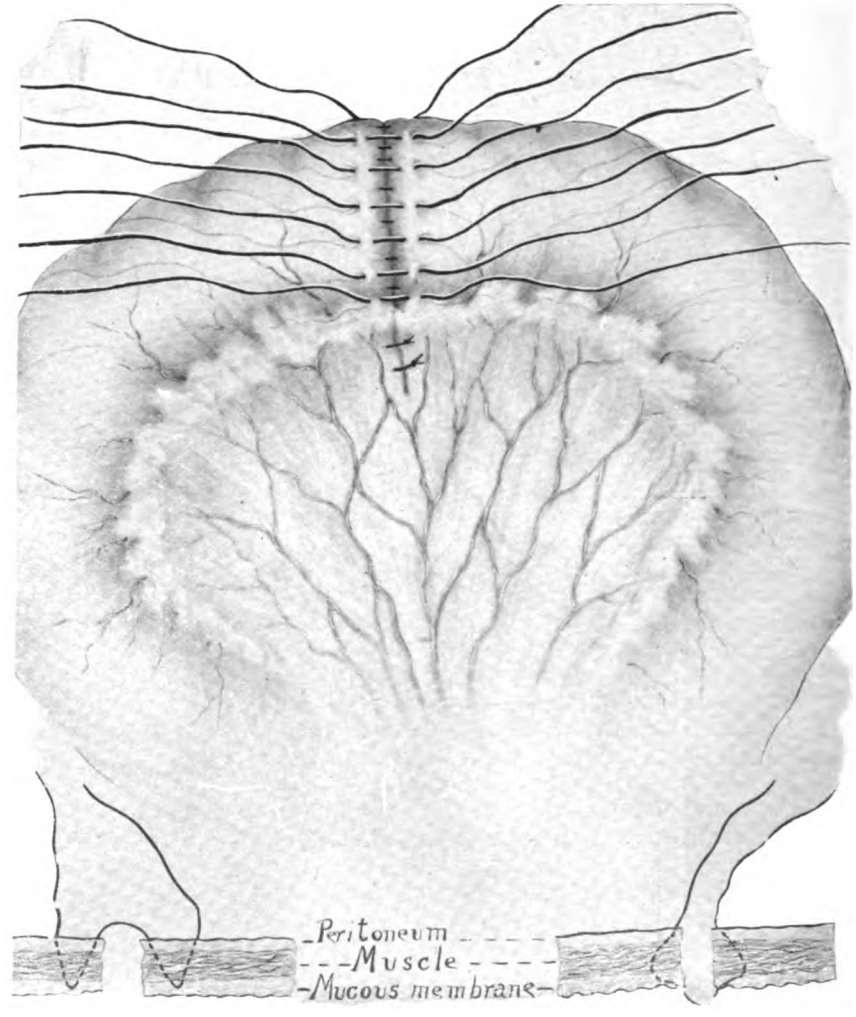
Many surgeons object to the use of an appliance which has to remain in the intestine in the form of a foreign body, and these consequently prefer a suture in place of the Murphy button or other appliance. All of these operations can be performed satisfactorily by the use of the suture. In our own work we have usually applied silk sutures in cases in which we did not use the button, but many surgeons prefer catgut.

Since publishing the third edition of this book we have entirely abandoned (as has been previously mentioned herein) the use of mechanical means for the purpose of uniting intestines with other intestines or with the stomach,

not because of any bad results, but rather because we can accomplish the same end so easily with the use of needle and thread and because we prefer not to introduce non-absorbable objects, and because the suture operation can now be done without the loss of much time and with excellent results.

Rules governing sutures. The same points must be borne in mind in the use of sutures as in the use of the button, namely:

1. The surfaces to be united should be covered with peritoneum.
2. The immediate vicinity of the attachment of the omentum should be avoided.



INTESTINAL ANASTOMOSIS: END-TO-END WITH SUTURES.

Herewith the manner of introducing the sutures is illustrated. To the right the suture grasps all of the layers of the intestine; this suture is first applied. To the left the suture passes through all the layers, including the submucous connective tissue, but not the mucous membrane, then passes out through all of these layers, issuing near the edge of the wound, then passing in and out again on the opposite side of the wound it is ready to tie. It will then unite two serous surfaces. This is the second row of sutures. This is Lembert's suture. Above, both rows are in place, but the outer row has been left untied. The latter is represented as interrupted, but continuous sutures may be used and these are preferred by most surgeons.

3. The two layers composing the mesentery should be held together by a carefully applied stitch, and the mesentery in the two segments should not be placed in accurate apposition.

4. The first row of sutures should grasp all of the layers of the intestinal wall, but the needle should grasp only a small portion of each layer.

5. The second row of sutures should be applied after the method known as Lembert sutures, which penetrate down to, but not through, the mucous membrane, thus placing in accurate apposition the peritoneal surface throughout the entire extent of the wound. The method has the advantage of affording an opportunity to make the anastomosis as large as one may desire. This is especially advantageous in making an anastomosis between portions of the colon, because in this intestine an extensive anastomosis is desirable. Interrupted or continuous sutures may be applied, but if the latter form is chosen, it is well to take a back stitch every fourth or fifth stitch, in order to insure greater security. The plate illustrates the manner in which the sutures are applied in an end-to-end anastomosis, but the same principle will apply in a side-to-side or an end-to-side anastomosis.

After-treatment. In a general way the after-treatment corresponds to that employed in gastro-enterostomy with the difference that food is given by mouth a little earlier and that active cathartics are not given until the button has been passed, when the Murphy button has been employed.

In the suture method cathartics are not given until the end of the second week, and the food is very carefully selected to prevent irritation; predigested foods, buttermilk, broth, gruel, egg-albumen, are most useful.

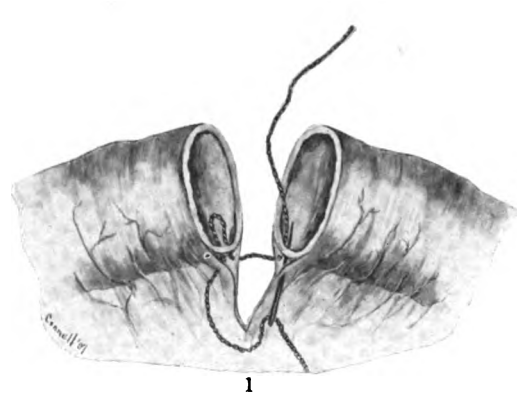
In using the suture method in place of the Murphy button we simply clamp, ligate and invert the end of each intestine and carefully suture it with Lembert sutures, then we find a point at which a side-to-side anastomosis between any portion of the ileum and the colon can be made without making tension upon either intestine, then we make an enterostomy at least five cm. in length, using the same method by means of clamps and sutures that has been described in connection with gastro-enterostomy. The only advantage this operation has over the one with the Murphy button lies in the fact that the opening can be made larger in this operation than in the previous one.

RESECTION OF THE SMALL INTESTINE

This operation may be indicated by the presence of gangrene of the intestine, in strangulated hernia or in volvulus, by severe laceration in gunshot or other wounds, by the presence of tumors or circumscribed tuberculosis or occasionally in cases of intussusception accompanied by gangrene. It may also be indicated by the presence of cicatricial stricture or intestinal fistula. The procedure itself is very simple and more depends upon the proper selection of tissue than upon the technique of the operation itself. Whenever the operation is performed in the presence of gangrene care must be taken to go a considerable distance beyond the suspicious tissue. A patient is much safer if one yard of intestine has been sacrificed unnecessarily, than he would be if the incision were made at the very border of the gangrenous tissue.

Technique. In excising diseased intestine it is well to grasp the mesenteric vessels carefully as one progresses and to ligate them before resecting the intestine. In case it does not seem safe to apply simple ligatures the mesentery may be transfixed with sutures, in order to prevent slipping.

After a sufficient amount of intestine has been separated from its attachment to the mesentery, care is taken to stop at a point sufficiently distant from a large branch of the mesenteric artery to prevent the injury of the



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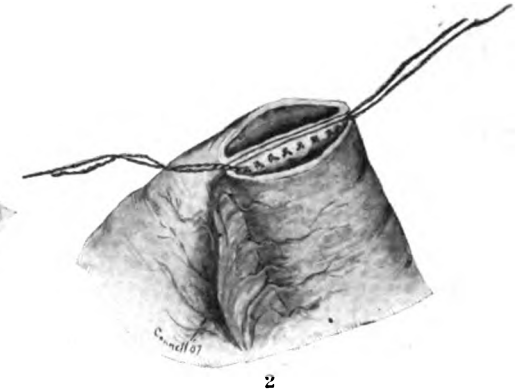

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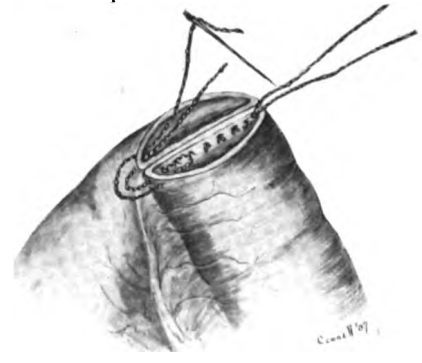
1. Insertion of mesenteric stitch, which obliterates triangular space.
2. Mesenteric stitch, and stitch at convex border inserted and tied, with ends left long for traction. Intervening stitches in place.



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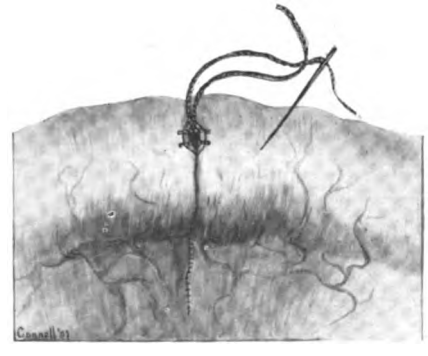
3. First, posterior, half completed, with first stitch in second, anterior, half inserted, ready for tying.



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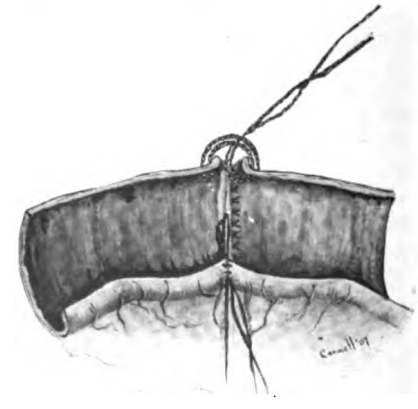

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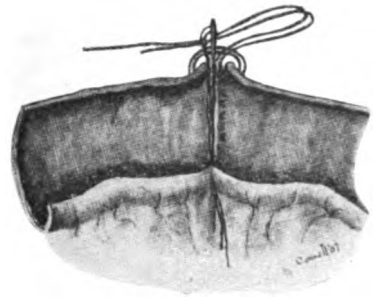
4. Stitches similar to one shown in Fig 3, inserted throughout the anterior half, all tied but the last stitch. This in place, with ends ready for tying.
5. Threaded needle is inserted eye first between two stitches into the lumen, at a point in the circumference about opposite to the stitch to be tied.

ILLUSTRATING THE CONNELL METHOD OF SUTURING. (COURTESY OF DR. GREGORY CONNELL.)



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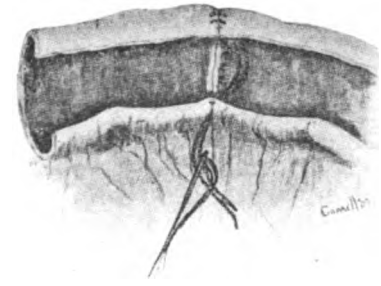

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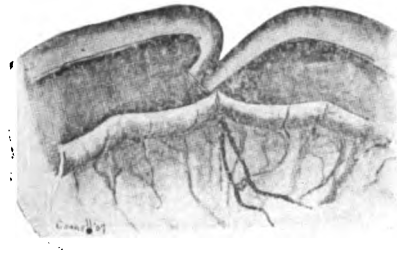
6. The threaded needle presents at the location of the last stitch. The ends to be tied are inserted into the loop formed by the needle and its thread.

7. By withdrawal of the needle and its loop, the cut ends at the site of the last stitch are inverted, and the ends to be tied are drawn to the outside through the opposite portion of the line of suture.



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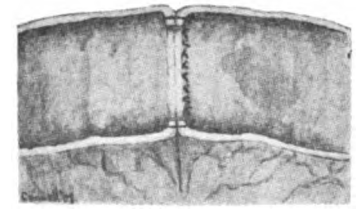

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8. Traction on suture ends causes the site of the future knot to come in contact with the mucosa of the opposite side of the bowel. The ends are tied, the knot sinks between the previously inserted stitches and is located on the mucosa.

9. The last knot is tied, the bowel has resumed its cylindrical contour, and the enterorrhaphy is complete, with all knots in the lumen.

ILLUSTRATING THE CONNELL METHOD OF SUTURING. (COURTESY OF GREGORY CONNELL.)

latter. The intestine is now held on either side by the hand of an assistant to prevent leakage, or this may be done by passing a narrow strip of gauze through the mesentery and tying just tightly enough to prevent extrusion. Then a large pair of long-jawed, clamp forceps is applied to either side of the portion to be excised, in order to prevent leakage from this portion. Then the intestine is cut away at either side, care being taken to cut away a little more from the point opposite the mesentery than on the mesenteric side.

Aside from protecting the tissue against gangrene this method results in a little increase in lumen at the point at which the enterorrhaphy is made, which is probably of importance especially in cases in which this is accomplished by the suture method. When the Murpny button is used there is never any narrowing at the point of union, because the cicatricial tissue formed is so slight that it can hardly be discovered by the unaided eye.

Silk stitches are then applied, being cautious to pass the stitch around the mesentery so as to hold its two surfaces together. The larger segment of the Murphy button is adjusted to the lower segment and the smaller one to the upper, and then the two segments are adjusted to each other. It is well to turn them a little so that the mesentery of the one part does not fall directly opposite to the mesentery of the other. A few sutures should be applied to cover the defect caused by the excision of the intestine in order to prevent unnecessary adhesions to the denuded surfaces.

In this operation we now use the suture method exclusively, applying one row of sutures which grasps all of the layers to secure accurate coaptation and to control the hemorrhage. This row of sutures carefully brings together the mesenteric attachment so as to prevent leakage at this point. A second row of continuous Lembert sutures is applied over the first row of sutures in order to unite peritoneum to peritoneum throughout. This method was introduced by Czerny many years ago and is still very satisfactory.

Gregory Connell has introduced the following method which is also most excellent, although it requires somewhat more dexterity and accuracy than that just described.

The Connell method. Nothing can be more perfect for an end-to-end anastomosis of the small intestine than this operation when performed by its author or by any one who has operated sufficiently often upon animals to obtain a high degree of accuracy. Each successive suture leaves the serous surfaces in ideal coaptation, as shown by the accompanying illustrations, and when the operation has been completed every suture is perfectly buried. There can be no hemorrhage because the sutures grasp every portion of the intestinal wall. The mesenteric attachment has been closed so that there can be no perforation at this treacherous point and there is no possibility of obstruction at the point of union between the two segments. The operation is, however, too difficult technically to be undertaken by an unskilled surgeon, who might still be able to safely close both ends of the intestine and make the lateral anastomosis described above.

Steps of the operation. The various steps of the operation have been so accurately described by Gregory Connell, its author, in connection with his illustrations that its seems impossible to misunderstand any detail, and in order to acquire the necessary skill to perform this operation it is but necessary to do it repeatedly upon dogs.

A dozen operations can safely be made upon a single animal if the surgeon will work as rapidly as he can, and if ether is administered carefully to the animal it consequently will not require many animals to acquire proficiency.

The excision of the diseased portion having been made and the bleeding from the mesenteric attachment controlled the first suture is applied from within outward, just outside of the mesenteric attachment, then it is carried

across to the other side and passed from without inward again just outside of the mesentery, then it is carried across to the other side and is passed into the lumen of the intestine where the suture is tied, perfectly closing the mesenteric attachment. The sutures from this point on are applied as indicated in the illustrations.

RESECTION OF THE COLON

Should it become requisite to resect the colon we are confronted with a condition which is somewhat different, inasmuch as the posterior surface of the colon is not covered with peritoneum. This makes an anastomosis much more troublesome, because union is much less certain in portions of the intestine not covered with peritoneum. In order to overcome this difficulty it is best to close the ends of the colon and make a side-to-side anastomosis of the two ends, choosing for this the surfaces covered with peritoneum.

In the transverse colon it is especially important not to infringe upon the attachment of the omentum for fear of causing subsequent necrosis. This anastomosis should never be made by means of a Murphy button, as there is liable to be an accumulation of hardened feces in the upper segment, which would be likely to obstruct the lumen of the button, for this reason it seems best always to make an anastomosis by means of sutures. It is usually still better to close both ends of the large intestine and make an anastomosis between the ileum and the colon below the point of resection, as in this way one secures the flow of liquid contents of the small intestine into the colon. In this case the button is perfectly safe but we now always use the suture.

If this plan is followed it is best to excise all of the colon on the proximal side of the malignant growth to prevent accumulation of fecal material in this portion, and it is usually most convenient to make the anastomosis between the ileum and the sigmoid flexure, because at this point the anastomosis can be effected without any tension upon either segment.

The end of the colon is closed by applying a strong pair of forceps across the intestine at the point at which the resection is contemplated. This will crush the soft tissues out of the grasp of the forceps and leave only the fibrous tissue in place. Then a silk, purse-string suture is applied to the proximal side of these forceps. This is tied tightly, which will cause it to be buried in the groove made by the heavy forceps. Then the diseased portion is cut away, leaving the portion of the tissue held by the purse-string suture to project from the part of the intestine which is left. This is then buried in the end of the intestine by the application of a row of Lembert sutures.

Gibson method. The most satisfactory operation for end-to-end anastomosis of the lower end of the colon that we have employed is that introduced by C. L. Gibson which we will describe in his own words.

The method has the advantage of extreme simplicity. It provides for a broad union of peritoneal surfaces and it reduces the tension necessary to a minimum.

The anastomosis does not result in any narrowing at the line of suturing.

"The upper cut edge of the gut is seized with two Kocher clamps and introduced by these into the lumen of the lower end and maintained there by an assistant. The extent to which it is feasible to accomplish this invagination will vary, depending on the laxity of the mesentery. If the latter is very short it may be elongated somewhat by a generous incision of its outer layer. As a general rule I should wish to carry the cut end of the upper segment so far down as possible, hoping more efficiently to direct the fecal current away from the suture line. The gut is rotated about a quarter circle so that the non-peritoneal covered surfaces do not entirely approximate in

the circumference. Eight to twelve interrupted silk sutures are introduced thus. A Lembert suture is begun on the lower segment, the needle issuing just short of the cut edge; on the upper segment the needle is introduced just above the line where the cut edge of the lower segment lies against the intact wall of the upper. When the knot is tied the free cut edge has been turned inward and only the peritoneal surfaces are in contact. A continuous running suture is applied over this area further invaginating the first ones, the Kocher clamps being previously withdrawn."

After-treatment. In a general way the after-treatment in which the colon is involved in the operation is the same as in operations upon the stomach or the small intestines; only predigested foods are given by mouth from the third day on and nourishment by enema is not employed. Hot water in small sips is given by mouth shortly after the operation and continued for the first few days.

One can easily choose a predigested food which is absorbed almost entirely from the stomach and small intestines which will sustain the patient until the union between the joined ends of intestine is sufficiently firm to make the use of general liquid diet safe. Ordinarily a very firm union exists after the third day, but occasionally the patients in whom these operations are indicated are much reduced in strength and consequently their tissues do not heal so rapidly.

INGUINAL COLOSTOMY

The only pathological condition indicating an inguinal colostomy is a stricture of the rectum which cannot be excised. This may be due to carcinoma or cicatricial contraction following a tubercular or a syphilitic ulcer, or an acute infection.

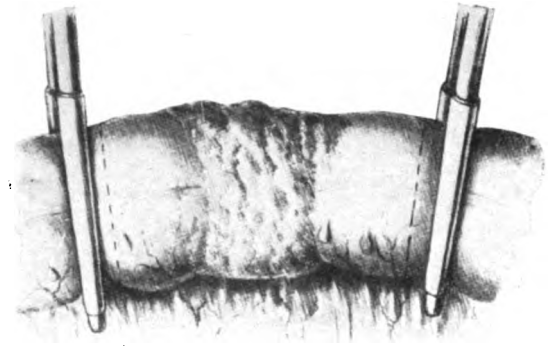
The operation may be intended only for temporary relief until the constricted portion of the rectum may be excised and the continuity between the intestine above and below this constriction has again been established, or it may be for permanent use. If it is intended only for temporary effect it is not necessary to provide for a means of keeping this opening closed at times to guard against the involuntary evacuation of the bowels. If the intestine is, however, intended to remain permanently open, it is desirable to secure such a provision. For the sake of brevity we describe only the latter operation, because it happens frequently that a colostomy which is primarily intended to be only for temporary relief will later be maintained permanently, either because it is not possible to establish a satisfactory communication through the natural way, or because the patient is so comfortable that he refuses to submit to the necessary operation to establish the communication through the rectum.

Technique. An incision is made parallel with Poupart's ligament, two and one-half inches in length, two inches above the anterior superior spine. Its center is crossed by a line extending from the left anterior superior spine of the ileum to the umbilicus. This incision extends down through the external oblique abdominal muscle, whose fibers it separates but does not cut.

The internal oblique abdominal muscle is then separated in the direction of its fibers, which extend nearly at right angles with the fibers of the external oblique. Then the transversalis fascia and peritoneum are severed in the same direction. This incision corresponds exactly to the McBurney incision, which has been described in the section on appendicitis, with the exception that it is on the left instead of the right side of the abdomen. With this incision the two abdominal muscles are not impaired, because none

of their fibers have been cut at right angles, and they are in a condition in which they can readily act as sphincter muscles.

A second incision is now made parallel with the first and of the same length, but four cm. nearer the anterior superior spine of the ileum. A third in-



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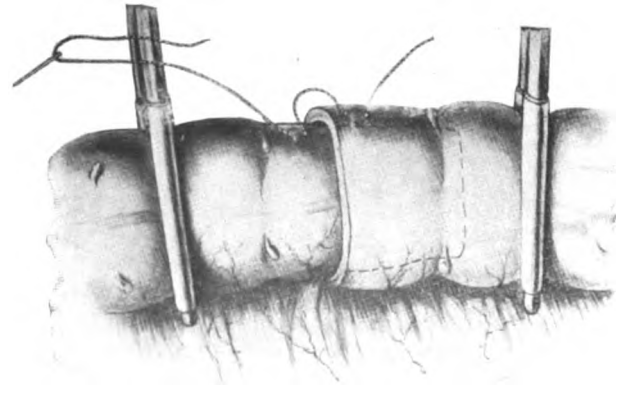
END-TO-END ANASTOMOSIS OF COLON.

1. The intestine is clamped with large forceps whose jaws are covered with rubber tubing to prevent injury to tissues. By courtesy of Dr. C. L. Gibson.

cision uniting these two at the upper end is made and the flap of the skin thus formed is dissected loose and covered temporarily by a piece of moist antiseptic gauze. The finger is then inserted into the abdominal cavity and passed along the ilium until it reaches the sigmoid flexure of the colon. This



2

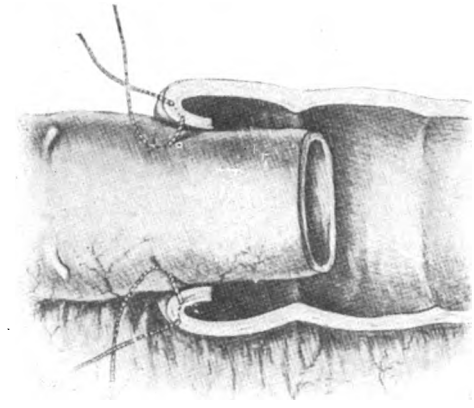
END-TO-END ANASTOMOSIS OF COLON.

2. The upper segment is invaginated into the lower and a Lembert suture has been applied which will invert the cut end of the lower segment when tied. By courtesy of Dr. C. L. Gibson.

is withdrawn through the incision in the abdominal wall. It can readily be recognized as large intestine from the fact that the longitudinal band of muscle fibers extends parallel with its upper surface and that there are attached to it numerous masses of fat, the appendices epiploica. It is best to bring out the upper segment of the sigmoid as much as possible, in order to prevent it

from prolapsing later on, a condition which occurs frequently in cases in which this precaution has not been taken.

The intestine is now held up to the light in order to select a point in its mesentery through which an opening may be torn without disturbing any of

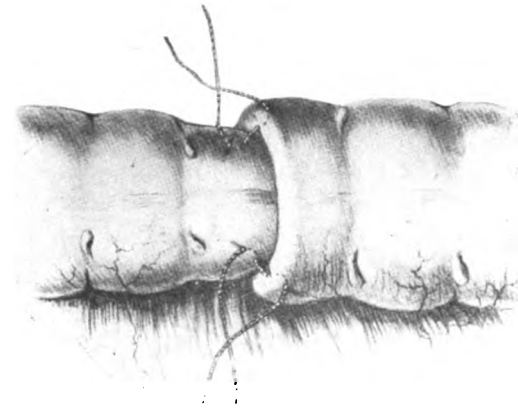


3

END-TO-END ANASTOMOSIS OF COLON.

3. The compressing forceps have been removed and the cut end of the lower segment inverted. By courtesy of Dr. C. L. Gibson.

the large blood vessels. This opening must be sufficiently large to admit the skin flap which has been prepared. The upper segment of the intestine is then placed outward and the lower segment inward and the skin flap is drawn through the opening in the mesentery. In this manner the upper seg-



4

END-TO-END ANASTOMOSIS OF COLON.

4. The completed operation with exception of tying sutures and introducing further sutures of the same kind. By courtesy of Dr. C. L. Gibson.

ment is bent over the outer edge of the abdominal wall and underneath the skin flap. Consequently, after healing has taken place the application of a pad over this part will cause the skin flap to act like a valve and will prevent the involuntary evacuation of the bowel contents. The incisions are now closed. In order to prevent any protrusion, a few stitches are inserted at-

taching the intestine to the skin. The operation is shown in the accompanying plate.

The loop of intestine is not opened until adhesions have formed, unless this is necessary on account of complete obstruction, in which case the wound is carefully protected and a large rubber tube covering a short glass tube is inserted into the upper segment and securely fastened by means of a strong, purse-string suture. This will compel the contents of the intestine to pass out through the tube, which is passed through the dressing, without soiling the wound. If this is not necessary a dressing is applied which will permit the gas to pass through this loop. Cotton is rolled in long bundles and these are applied about the protruding intestine after the fashion of logs in a log cabin. These bundles are held in place by means of broad adhesive strips and an abdominal bandage.

After from two to five days the intestine is cut across and then the evacuations can occur without interfering with the healing of the wound. Aside from the advantage there is in securing a means of closing the upper segment when desired, this method has the further value of leaving the two openings of the intestine so far apart that there can be no passage of feces from the upper into the lower. The evacuations will now occur through the opening a, which is sufficiently separated from the opening b, communicating with the segment leading to the rectum, to prevent any of the evacuations from finding their way into this canal. This portion of the intestine can, however, be cleansed by irrigating through this opening.

In case it should become desirable later on to close the artificial anus this may be accomplished by inserting one branch of a clamp through each of these openings and gradually tightening the pressure until a communication has been established, when the openings can readily be closed.

After-treatment. Until the protruding loop has been cut only hot water and small quantities of predigested food are given by mouth. After this time general liquids, and after a week light diet is given.

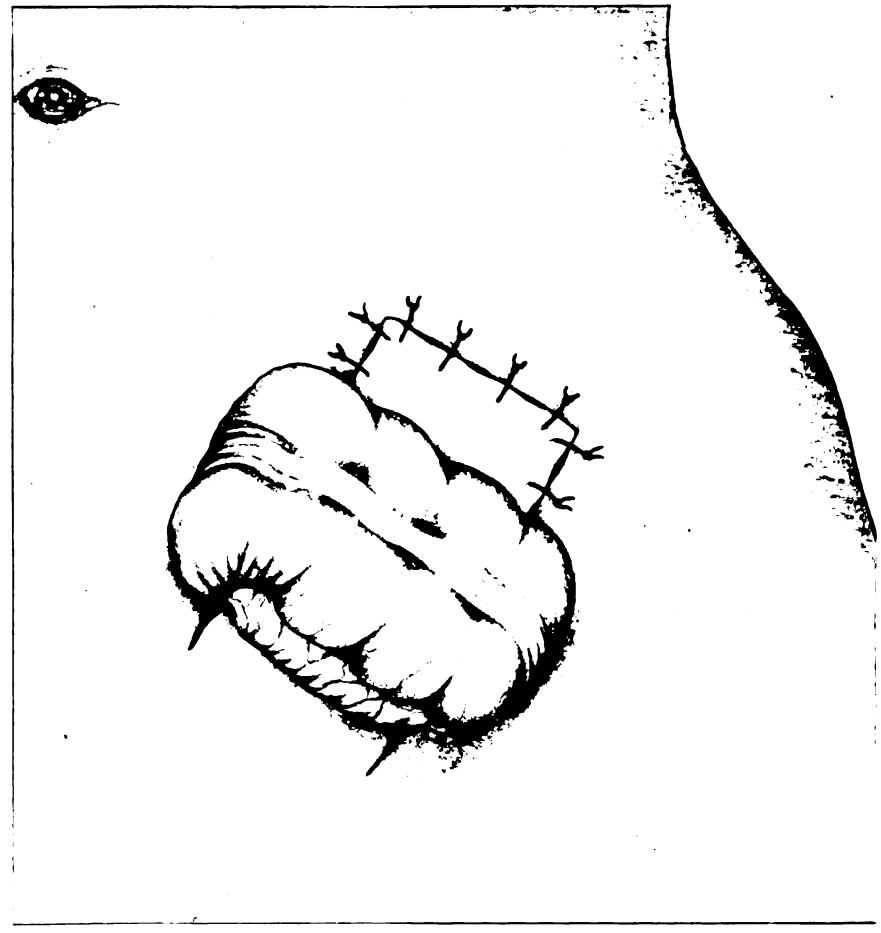
This operation is usually performed in old persons greatly reduced in strength and such do not well bear lying quietly in bed. It is consequently best to permit them to occupy a semi-sitting position within a day or two after the operation, and to leave the bed within a week or ten days later.

After the intestine has been opened a cathartic, preferably castor oil, should be given, and this should be followed by several enemata in order to remove fecal accumulations which frequently exist in large quantities above the constriction, even if a diligent attempt has been made to evacuate the bowels before the operation. Frequently the lower segment contains many of these masses, which may usually be removed by irrigation but may occasionally require a blunt scoop. It is well to examine the opening by inserting the finger within the lumen of the intestine through the abdominal wall, because occasionally not sufficient space has been allowed for the evacuation of the bowels and the free passage of gas. This can be remedied readily by a slight incision.

These patients should be instructed to regulate their diet so as to avoid constipation and then to take a simple cleansing enema once a day to insure a free evacuation of the bowels. Thus they can usually be entirely free from any annoyance because of the artificial anus. A small pad of cotton should be worn over the opening, held in place by a simple abdominal bandage. In case there is any annoyance from escaping feces a substantial pad may be held in place over the opening by means of an elastic bandage, which will

compress the intestine underneath the skin flap c, over the edge of the abdominal wound sufficiently to overcome this annoyance.

If there is not enough force in the colon to produce an evacuation, it is sometimes best to insert a large rectal tube after giving the enema and to effect the evacuation through this.



INGUINAL COLOSTOMY.

The colon is drawn out through the incision in the abdominal wall; its mesentery is split; a rectangular flap of skin is cut and drawn through the slit in the mesentery and sutured in place. The longitudinal muscular band is shown upon the surface of the sigmoid flexure of the colon.

The intestine will be cut across at the point indicated by the dotted line, the openings will then retract to the points a and b.

Alternative procedure. In cases in which it is plain at the time of the operation that it will never be possible to re-establish communication between the upper and lower segments, on account of the obstruction in the rectum, we prefer to perform an operation which carries out the upper segment through the abdominal wall. This is required especially in cases of carcinoma in which the growth has invaded the surrounding tissues to such an extent that a complete removal is impossible.

In this operation the first steps are the same as those described above but instead of forming a skin-flap to carry underneath the loop of intestine the second incision, five cm., is made parallel to the first and the skin and superficial fascia are undermined so as to form a tunnel through which the upper segment of the colon is later to be carried, then the abdomen is opened a second time through a median incision ten to fifteen cm. long between the umbilicus and the pubis. The sigmoid flexure is brought out through this opening, its mesentery is clamped and ligated according to the method described in excision of the colon. About ten to fifteen cm. of the intestine is made free from the mesentery, then two large clamps are applied transversely, at a point leaving enough tissue in connection with the lower segment to make sure that the upper segment is at least ten cm. beyond any diseased tissue and at the same time enough to make an inversion of the free end of this segment into its lumen easily possible. The upper segment must contain a sufficient amount of free bowel to reach through the inguinal opening and through the canal underneath the skin-flap, and beyond the margin of the second incision, without the slightest tension.

The end of the lower segment is then ligated and inverted into its lumen and the wall closed over it with a purse-string suture which is reinforced with a row of Lembert sutures.

The upper segment is then also ligated to prevent the escape of any contents, then it is carefully covered with gauze and carried out through the inguinal incision and underneath the skin-flap where it is sutured in place, so as to project at least one cm. beyond the surface of the skin. A few sutures are applied between the wall of the bowel and the peritoneum and transversalis fascia at the inguinal wound in order to support the segment and at the same time to prevent any loop of the small intestine from being forced out along the side of the colon.

Then the wounds are all sutured and the same dressing is applied as in the previous operation.

It is important to determine which is the proximal and which the distal segment because in these cases with long-continued obstruction the sigmoid flexure is often very long and sometimes twisted upon its mesentery so that it is quite possible to confound the two segments. This would, of course, be a fatal error unless it were discovered in time to be remedied.

The after-treatment is the same as in the previous operation, the ligature closing the upper segment is removed on the second or third day. It is important in this operation not to permit any fecal matter to remain in the lower segment above the point of constriction, as this might result in perforation.

In many of these cases the removal of irritation caused by the passage of fecal material over the surface of the carcinoma will cause the malignant growth to remain stationary in its development for a long time.

We have seen many of these patients take on a normal appearance, gain greatly in weight, return to their occupation and imagine themselves cured for months or even years. This is true especially in cases of very slow growing annular carcinoma of the rectum in which the bad condition of the patient is due to prolonged absorption of fecal material which had accumulated above the seat of obstruction before this condition was relieved by establishing a colostomy.

SIR ARBUTHNOT LANE'S SURGICAL TREATMENT FOR CONSTIPATION

Several years ago our attention was directed by Lane to the fact that many patients suffer severely from the results of absorption of putrid substances from a colon containing enormous quantities of fecal matter prevented from being evacuated normally. Lane demonstrated the fact that these accumula-

tions remain indefinite periods of time, the evacuations that may occur from time to time never emptying more than the lowest portion, and frequently passing directly by the accumulations in the colon on their way from the ileum to the rectum.

This condition is due to faulty development as regards the position especially of the cecum and transverse colon, the latter usually having its position low down in the abdominal cavity. It is further exaggerated by constricting or obstructing bands, and still further by habitual neglect on the part of the patient to secure regular, complete daily evacuation of the bowels.

When the transverse colon and the cecum have once become permanently loaded with hardened feces the weight of the mass itself will result in the dropping down of the cecum and transverse colon, and this in turn will serve to still further increase the condition of constipation.

In many of these cases Lane has obtained remarkable results, restoring patients who were complete physical and nervous wrecks to good health and strength by exercising the entire colon and implanting the ileum into the sigmoid or into the upper portion of the rectum; or in milder cases by resecting the ileum fifteen cm. from its entrance into the cecum and implanting the proximal end into the sigmoid flexure.

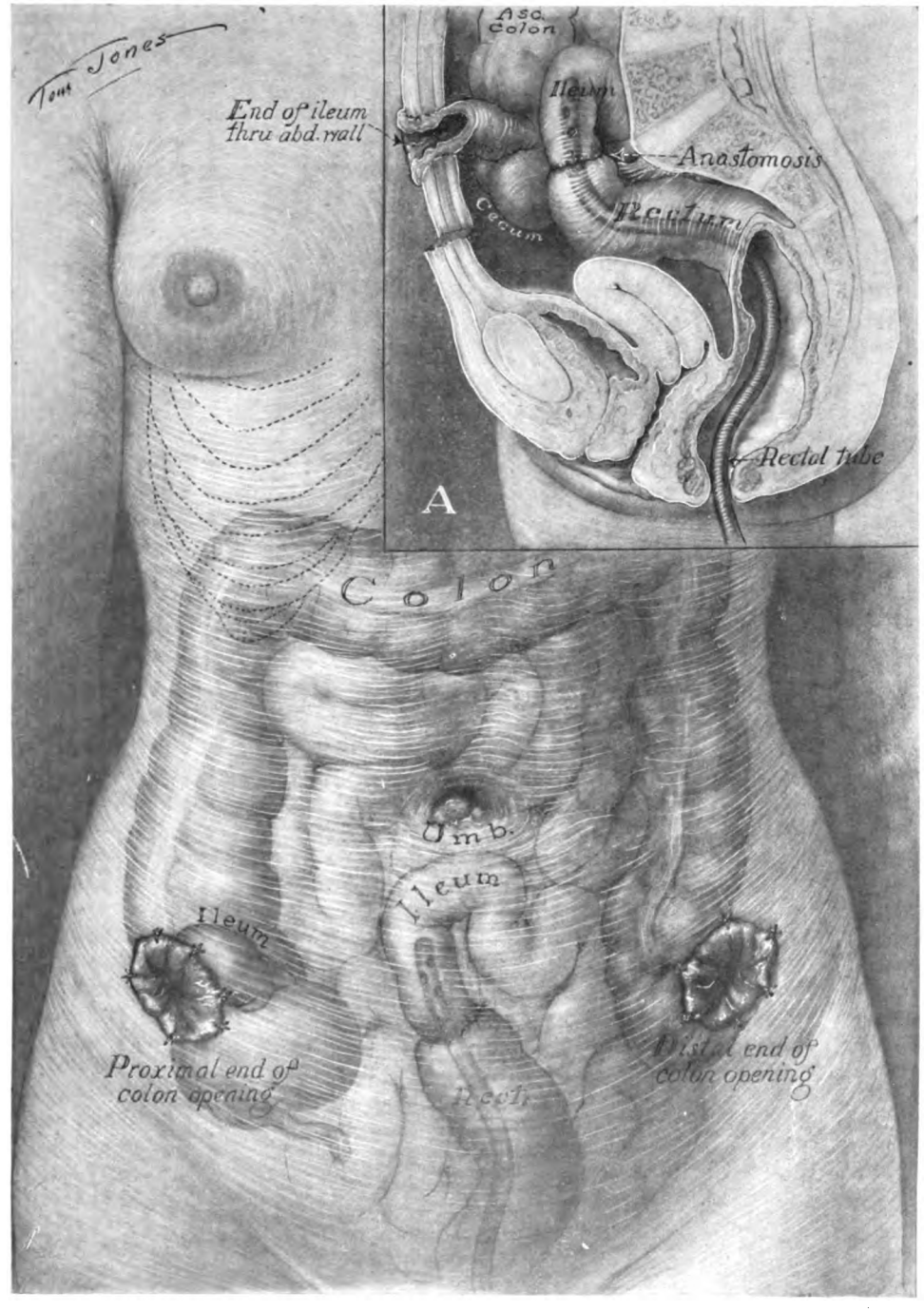
The following description of the various steps of the operation is taken from Lane's work on this subject. We have performed the operation several times with satisfactory results and have seen a number of Lane's patients, all of whom showed excellent recoveries.

Lane's technique. "In no circumstances should operative interference be contemplated till the surgeon has satisfied himself that every other means of treatment have failed, whether medical or mechanical.

"In the treatment of such degrees of overloading of the large bowel as cannot be treated efficiently by measures short of operation, I have obtained considerable success by dividing constricting bands and adhesions, and by subsequent careful attention to the proper functioning of the bowel. In a considerable proportion of cases, and more particularly in women, such means are insufficient, as at the best they only afford temporary relief, since the obstruction recurs sooner or later.

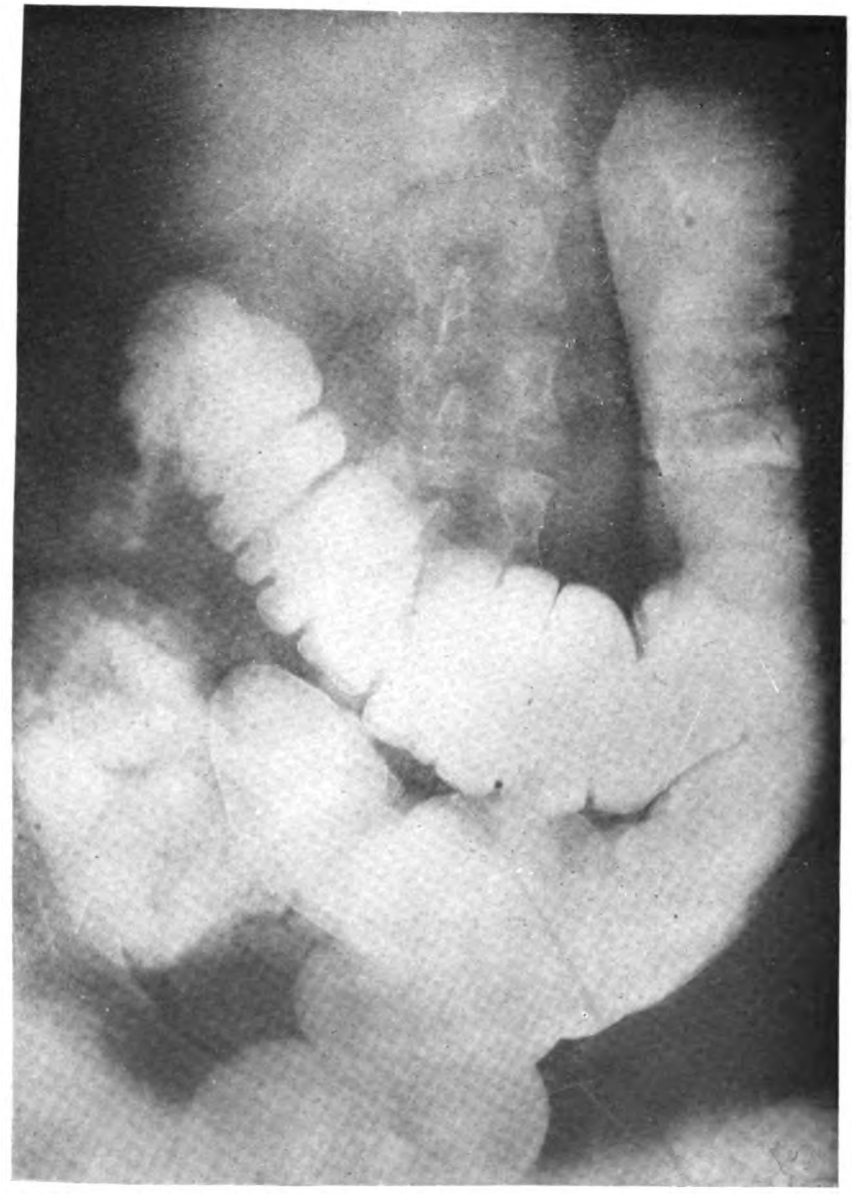
"In my earliest cases, after the appendix had been removed and the cecum and flexures freed from adhesions on one or more occasions, with transitory benefit, I looked about for some means of relieving the patients of the cecal pain from which they suffered and for the relief of which they were ready to submit to any operation. Pain was the chief symptom of which they complained.

"In the first case I merely made a lateral anastomosis between the ileum and sigmoid, but the early return of cecal pain obliged me to divide the ileum. In several of the cases in which I had divided the ileum, after an interval of months the patients were occasionally annoyed by the presence of hard, dry masses of fecal matter in the cecum. They produced no auto-intoxication, but the discomfort arising from their presence and from flatulent distension was sufficient to call for the removal of the large bowel as far as the splenic flexure. These hard masses of feculent material are not necessarily the result of regurgitation, but are probably formed in the large bowel. A still more extended experience showed me that if any portion of the large bowel is left above the junction with the ileum it tends to dilate sooner or later. This dilatation may interfere with the satisfactory evacuation of feces, and discomfort or pain may ensue because of its distension by fecal matter or gas. Therefore, to overcome completely the constipation as well as the septic absorption, the



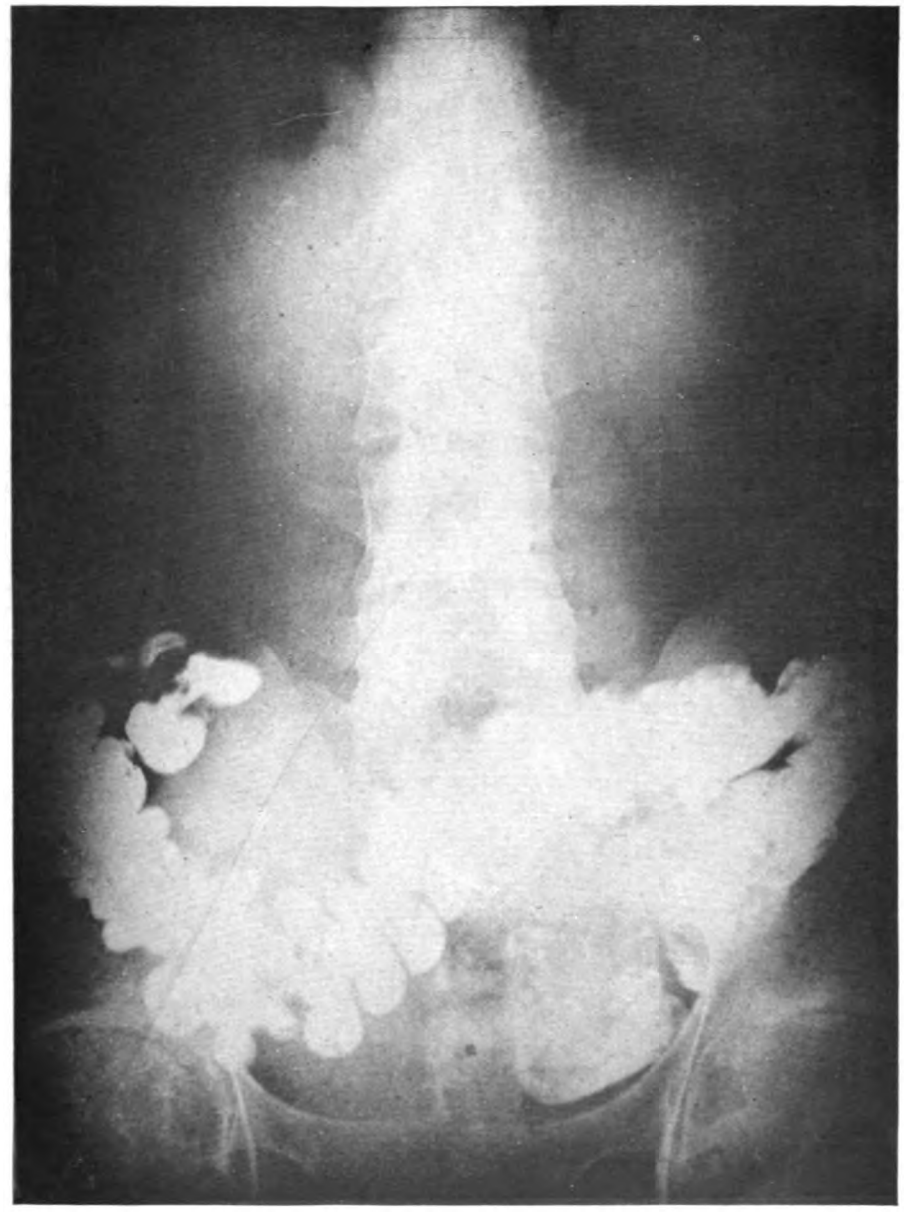
OPERATION FOR THE ELIMINATION OF THE ASCENDING, TRANSVERSE AND DESCENDING COLON FOR THE RELIEF OF INTESTINAL STASIS.

The ileum has been severed 10 cm. from the cecum and the cecal end passed through a McBurney incision, making a permanent colostomy at this point. The sigmoid has also been severed and the end of the descending colon passed through a similar McBurney incision on the left side. An end-to-end anastomosis was then made between the proximal end of the ileum and distal end of the sigmoid, and a rectal drainage tube passed up into the ileum. The colon can now be flushed out through its two colostomy openings. By this operation the patient is relieved of the intestinal stasis without undergoing the great risk of a complete excision of the colon.



INTESTINAL X-RAY.

Radiogram after colon injection showing ptosis of transverse colon, angulation at splenic flexure, incomplete filling of ascending portion (adhesion band) and redundant sigmoid.



INTESTINAL X-RAY.

Radiogram of injected colon showing marked ptosis of colon, the entire large bowel lying in the pelvis.

INTESTINAL X-RAY.

Radiogram of injected colon. Adhesion causing constriction at A; greatly dilated transverse and ascending colon, B; distended cecum, C; redundant sigmoid.

large bowel should be removed as far as its junction with the ileum, which is effected in the upper part of the rectum or in the adjacent sigmoid.

"Therefore, when I recognize that the mechanics of the intestines have been altered to a degree that cannot be rectified satisfactorily by the division of bands, etc., I divide the ileum at a distance of about five or six inches from the cecum. This can be done rapidly and securely by encircling it by means of a catgut ligature.

"The ileum is divided by the cautery immediately beyond the ligature. The stump is then buried in the proximal bowel by means of a purse-string suture which encircles the bowel and perforates its peritoneal and muscular coats about three-quarters of an inch above its ligatured extremity, rendering the closure absolutely secure.

"The acquired adhesions and peritoneum which bind the cecum and ascending colon to the abdominal wall external to them are divided, and the bowel is raised till the vessels which supply it are exposed. These are grasped in compression forceps and firmly ligatured. The vessels supplying the transverse colon are similarly treated, and finally the descending colon and perhaps the sigmoid are removed, the upper limit of the rectum or the lower part of the sigmoid being occluded in the same manner as the ileum.

"Originally I had been satisfied to divide the transverse colon at the splenic flexure, closing the distal portion in the manner already described, but for the reasons I have given I now remove the descending colon and a portion or the whole of the sigmoid, closing the large bowel at, or just above, its junction with the rectum.

"The termination of the ileum and the sigmoid or rectum adjacent to it are brought into convenient apposition, and a perfectly secure and reliable lateral anastomosis is made by means of a double row of continuous sutures, the inner row of which perforates all the coats, while the outer does not enter the lumen of the bowel.

"If the surgeon prefers it, the ileum and rectum may be united end-to-end. This is the ideal way, since any tendency to pouching which exists in the case of lateral anastomosis is avoided. The objections to it are that it is not so safe because of the difference in the circumference of the two pieces of bowel, the frequent very great tenuity of the wall of the ileum, and the difficulty occasionally met with in dealing with the mesenteric attachment.

"Subsequent dilatation of the ileum beyond the seat of lateral anastomosis may be avoided by sewing down and obliterating the lumen of the distal gut right up to the aperture of communication with the large bowel.

"Finally, a fine gut ligature is passed through the free incised margin of the mesentery of the ileum, and then beneath the peritoneum forming the outer wall of the meso-rectum. This, when made tight, brings the rectum to the middle line of the pelvis and fixes it securely in that situation immediately beneath the position occupied normally by the divided end of the ileum. The ligature also closes the interval between these two mesenteries, through which a loop of bowel might otherwise pass and give trouble.

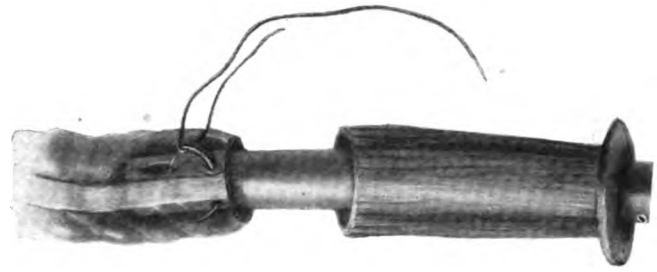
"There are many cases in which the patient is unable to sustain the strain of the removal of the large bowel, but can that of division of the small bowel and the establishment of a connection between it and the sigmoid or rectum. This operation relieves the patient of the toxemia.

"Should the symptoms resulting from the distension of the colon cause sufficient trouble the large bowel can be removed at a later date with much less risk.

"Again, there are a number of cases of extreme toxemia, who have no

pain, and in whom the division of the ileum and its connection with the end of the large bowel is sufficient, since it relieves the patient of all trouble.

"The stomach is exposed and is usually found to be dilated to a varying extent. In this condition the pylorus is hung up by adhesions to the liver

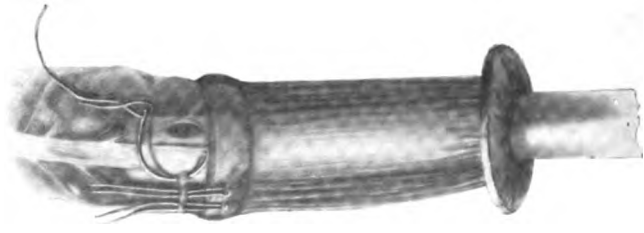


1. Showing Tube Introduced Through the Rectum Up into Proximal Sigmoid, and Placing of Catgut Suture.

and gall-bladder. These are freely divided. I have employed gold leaf to obviate the re-formation of adhesions with apparent advantage. The adhesions tend to re-form since the mechanical factors determining their development continue to exist. When the weight of the transverse colon has been

2. Showing Tube Used for Bringing the Two Ends into Apposition, and First Row of Sutures Placed.

removed, during the period of recumbency following on the operation, the dilatation of the stomach usually disappears more or less completely. On several occasions after a varying interval from the operation of resection of the large bowel, the dilatation of the stomach has become a feature of sufficient



3. Showing Intussusception Accomplished and Outer Row of Sutures Placed.

importance to require its more effective drainage by a gastro-enterostomy. This operation has afforded complete relief of the gastric symptoms. I have seen cases of chronic intestinal stasis in which a gastro-enterostomy alone had been done for dilatation of the stomach with very distinct disadvantage to the

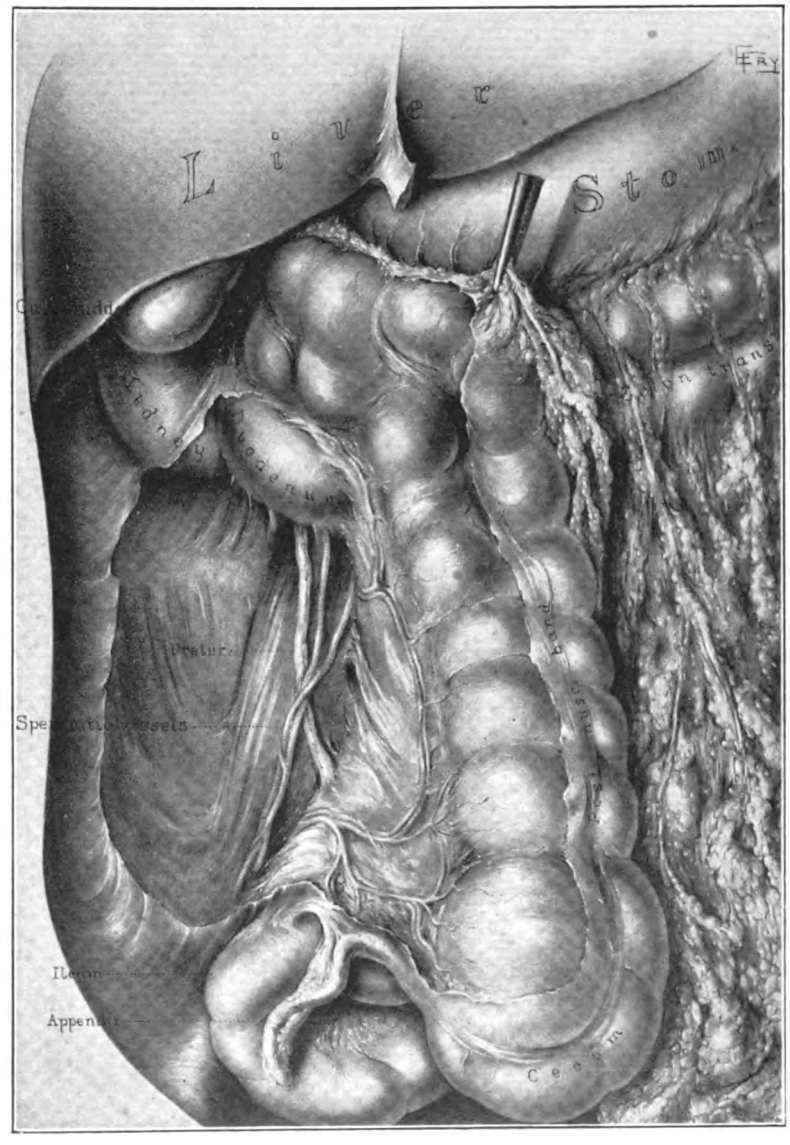
patient. The surgeon has not recognized the sequence and he has brought the operation of gastro-enterostomy into disrepute. Indeed, I have seen it frequently stated that gastro-enterostomy is of no service unless there be obstruction to the pylorus by growth or cicatrix. To attempt to relieve symptoms by performing a gastro-enterostomy in the first instance in the dilatation of the stomach that follows upon chronic intestinal stasis is of little or no avail."

CARCINOMA IN THE UPPER PORTION OF THE RECTUM

If a carcinoma is located in the upper portion of the rectum it is often impossible to approach it from below, but it can be removed with ease through an abdominal incision. This operation is indicated only if the tumor is confined entirely to the intestine, because if the surrounding tissues have been invaded the removal of the tumor would in no way retard the progress of the disease.

Technique. Under favorable conditions, then, the following operation is indicated: The patient is placed in the exaggerated Trendelenburg position. An incision is made through the linea alba extending from the pubis to a point an inch below the umbilicus. The intestines are held away by means of moist, gauze tampons. The sigmoid flexure is then found and grasped between two pairs of long-jawed pressure forceps placed side by side at a sufficient distance above the tumor to make sure that every portion of the growth is several inches below the lower pair of forceps. The intestine is then severed between these two pairs of forceps and a second incision is made in the left inguinal region, corresponding to McBurney's incision for the removal of the vermiform appendix only upon the opposite side, care being taken to separate the fibers of the external and internal oblique abdominal muscles, as described in the previous operation. A pair of long-jawed pressure forceps is then passed through this opening and attached to the upper segment, which is withdrawn through this wound and carefully sutured to its edges, after a large rubber tube surrounding a glass cylinder has been inserted in this segment and fastened in place by means of a purse-string suture. This will permit the escape of gas and feces without any danger of soiling the abdominal wound. The pair of forceps upon the lower segment is lifted toward the abdominal incision and the posterior attachment of the intestine below these forceps is successively grasped by means of pressure forceps, and as the attachment is grasped the intestine is cut loose. In this manner the entire intestine can be loosened without the slightest danger of hemorrhage. If the diseased portion is not extensive two other pairs of pressure forceps are placed parallel to each other at a sufficient distance below the tumor to insure its complete removal. The intestine is cut off between these two forceps and the tumor removed, together with the forceps above and below it. A purse-string stitch is applied around the lower segment, and the edges caught by means of the pressure forceps are inverted. Then the entire abraded surface is covered with peritoneum and the abdominal wound closed. Occasionally the sigmoid flexure is so long and its attachments so loose that it is possible to withdraw the upper segment through the lower segment and treat according to the method introduced by Gibson, which has already been fully described.

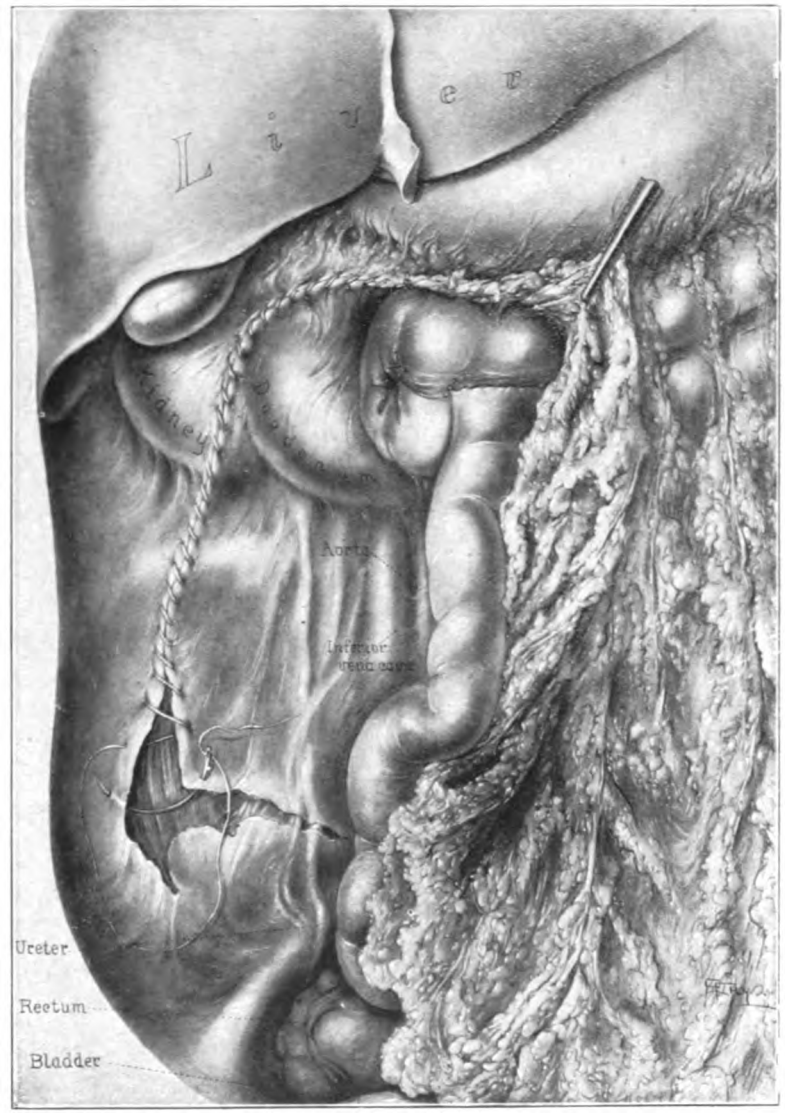
At this point we wish to emphasize the fact that it is most important to make a free excision of these tumors, and that in no case should one make a less thorough operation for the sake of maintaining the natural instead of the artificial anus.



EXCISION OF CECUM AND ASCENDING COLON (A).

(As described by Dr. W. J. Mayo, *Journal A. M. A.*, August 8, 1914.)

Fig. A shows the manner of exposing the blood-vessels supplying the cecum, also the ureter and the loop of duodenum, which can easily be injured during the operation unless the surgeon's attention is directed toward the proximity of this structure to the field of operation.



EXCISION OF CECUM (B).

Fig. B shows the operation completed with the exception of the lower end of the peritoneal defect, which is being closed with a continuous catgut suture. The liver, gall bladder, stomach, lower end of the right kidney and duodenum are in view, also a portion of the sigmoid flexure of the colon below the portion of the ileum, which has been united with the transverse colon by an end-to-side anastomosis, and the closed end of the resected transverse colon. These structures, together with the omentum, have been drawn to the left in order to show the abdominal aorta and the inferior vena cava.

INTESTINAL FISTULA

Causes and incidence. Intestinal fistulæ at the present time occur most frequently after operations performed for the relief of acute appendicitis complicated by the formation of extensive abscesses. The fistulæ are more common in cases in which the appendix itself has not been removed, or in which the appendix has been removed at an inappropriate time or with extreme manipulations. The condition also occurs after other operations in which the intestinal wall has been injured either by disease or by the operation, or by the drainage tube which was applied after operation. It is more common after operations which have been performed for the relief of inflammatory conditions, such as pyosalpinx. It also occurs after operations for strangulated hernia and after those for the resection of any portion of the intestinal tract. After operations for the relief of tubercular peritonitis, in which the adhesions between loops of intestines have been separated, intestinal fistulæ frequently occur; they also follow direct injury to the intestinal tract.

Spontaneous cure. A considerable proportion of intestinal fistulæ will heal if absolute rest is secured as nearly as possible. This may be accomplished most readily by first emptying the alimentary canal thoroughly by means of large, repeated doses of castor oil, which will remove not only the food, but also all mucus contained in the canal. The fistulæ should be thoroughly cleansed by irrigation. This should be followed by feeding the patient exclusively by means of nutrient enemata. In this manner the intestinal canal may be kept relatively empty for a number of days, and in the meantime the openings in the intestine are likely to decrease in size unless there is a marked eversion of the mucous membrane. If this condition is present nothing but a radical operation will bring relief. The same is true if there is a stricture or narrowing of the intestinal canal distal to the fistula. Occasionally this will prevent the healing of an intestinal fistula which would otherwise respond readily to treatment.

Operative technique. It is usually wise to postpone the operation until the course above described has been thoroughly tried, because one will frequently succeed by the simpler method even after the fistula has existed for a considerable time, and this is especially true of fistulæ in portions of the colon where the bowel is covered with peritoneum.

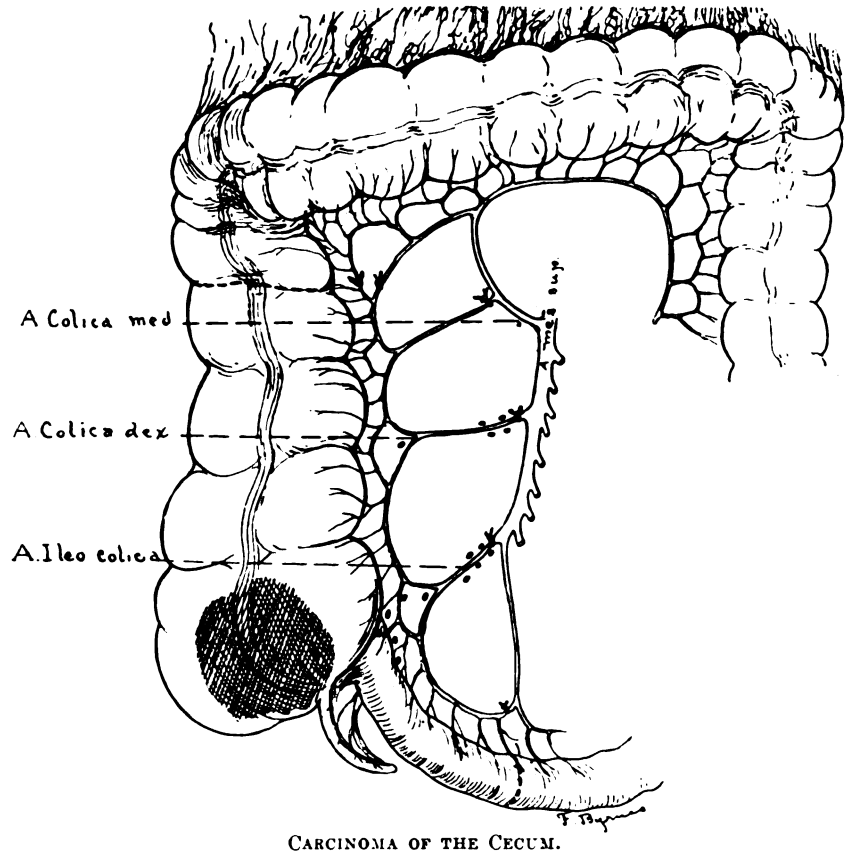
The incision through the abdominal wall should be made at some distance from the fistula so as to avoid the adhesions which one is sure to encounter at the point where the abdominal wall is penetrated by the fistula. The amount of traumatism necessary for performing the operation required is very much reduced if this precaution is taken, because the conditions may be determined much more perfectly if the abdominal cavity is opened at a point quite away from these adhesions. The incision should be sufficiently long to permit of performing the entire operation in full sight.

After the abdominal cavity has been opened all of the intra-abdominal organs should be tamponed away from the portion of the intestines involved, then these should be loosened from the abdominal wall and carefully brought out so that all abrasions upon their surfaces may be carefully repaired. Attention is then given to the fistula itself. In cases following appendicitis operation the fistula most frequently enters the appendix at the point at which that organ was perforated during the acute attack. All that needs to be done in such instance is to remove the entire appendix after the methods described heretofore. In these cases the method of separating the appendix first from its cecal end and then dissecting it out distally is especially useful. It may be dissected out together with the fistula. The abraded surfaces upon the intestines which have been adherent must be carefully covered with peritoneum.

It is usually well to pass a drain through the opening in the abdominal wall through which the fistula extended down to the seat of injury in the intestine, and then to completely close the new opening in the abdominal wall. If the fistula is in the cecum it is usually not difficult to close it by means of sutures if the following points are borne in mind:

1st. The tissues to be sutured must not be cicatricial in character.

2nd. The sutures must be applied with great accuracy so as to have a perfect coaptation of surfaces.



CARCINOMA OF THE CECUM.

Dotted lines indicate points of resection.

3d. The sutures must not grasp too large an amount of tissue.

4th. The entire line of sutures when completed must be covered with healthy peritoneum or with a piece of omentum.

A drain should be placed down to the point of suture as described above.

In fistulæ of the small intestines it is usually advisable to make a resection of a considerable portion of the bowel, in fact, a sufficient amount should be removed to make the anastomosis between the ends in entirely healthy tissue. This can then be accomplished by means of the Murphy button, as described before; or by means of the continuous or interrupted intestinal suture, also described; or the ends of the intestine may be closed and a lateral anastomosis may be made after the method already outlined, which is the safest, as a rule. In any event the important point to be borne in mind is

that the operation must be done entirely in healthy tissue. The loss of a number of feet of small intestine is of practically no importance to the patient, but if too little is taken away for the sake of saving a small portion of intestine a subsequent perforation is liable to occur.

Fistulæ following operations for the relief of tubercular peritonitis can usually be healed only if the tuberculosis affects but a relatively small portion of the intestine which can be removed *in toto*. In this case the same conditions obtain which have just been described. If the tuberculosis is not relatively circumscribed then these fistulæ can virtually never be cured.

Occasionally an intestinal fistula is complicated by such extensive adhesions that it seems unsafe to loosen them, and it then may become necessary to make a lateral anastomosis between the intestine going toward the fistula and that coming from it in order to short-circuit the gut at this point. It is best to pass a silk-purse-string suture about the portion of bowel to be eliminated just beyond the anastomosis, in order to prevent intestinal contents from entering this portion. The suture should be applied subperitoneally and tied just tightly enough to accomplish this end without causing pressure necrosis.

INTUSSUSCEPTION

This is encountered usually in very small children although it occurs occasionally in children ten years of age or even older, and it may happen in the adult, but so rarely that we have never seen such an instance. Our eldest patient was not more than twelve years of age, while we have treated many children between one and four years old.

Typical case. The child is sixteen months of age and had been perfectly well until six hours ago when she suddenly began to complain of severe colicky pain in the abdomen. She desired to evacuate her bowels but was unsuccessful. Half an hour later a second attempt was unsuccessful and an enema which was given in the hope of relieving the condition came away clear, although a slight amount of mucus was expelled directly after. From this time on the patient has had repeated attacks of pain, very severe, causing the child to cry out and draw its thighs upon its abdomen.

The family physician gave an enema and a mild sedative and advised the use of calomel later on in case relief should not come. A second physician was called and applied hot fomentations to the abdomen and recommended consulting a surgeon later. The pain becoming constantly more severe and the parents having had experience the previous year with an acute perforative appendicitis in a child two years older, the consultation was arranged for promptly.

Present condition. The child being undressed we find a well-nourished, perfectly healthy appearance, with excellent color and well-formed body. Lungs and heart are normal. While inspecting the abdomen a bulging appears opposite the middle of the right rectus abdominis muscle, at the same time the child draws its thighs up over the abdomen and begins to cry, evidently because of severe intra-abdominal pain.

All of these symptoms subside in about two minutes. Palpation of the abdomen reveals a hard, sausage-like body to the right and a little above the umbilicus in the region normally occupied by the hepatic flexure of the colon. The abdominal muscles over this mass are somewhat tense. Nothing else abnormal can be discovered. Some mucus which has been expelled is slightly streaked with blood. Upon again questioning the nurse the fact that the child fell from a foot-stool upon the carpet early in the afternoon was elicited, but as the child had arisen at once and had not complained the matter had not impressed itself upon the maid until she was questioned specifically. The child had taken a little water since the time of the fall but no food.

The second physician had made a diagnosis of intussusception which we confirmed at once upon making the examination just described. The child was

brought to the hospital and we will make an abdominal section without any delay, because all of these cases operated within the first twenty-four hours after the beginning of the attack have made a perfect recovery, while those in whom the operation had been delayed longer showed much less favorable results.

The patient will be immediately anesthetized with ether, then the skin covering the abdomen will be disinfected in usual manner and then we will split the right rectus abdominis muscle longitudinally at a point opposite the umbilicus by an incision fifteen cm. long, dividing the muscle as nearly as possible into halves. It is best to make the incision sufficiently long to prevent trauma to the intestine during the subsequent manipulations.

The cecum, a portion of the ileum and the vermiform appendix have been telescoped into the transverse colon. Seeing this mass before you there is temptation to seize the ileum and make traction upon it for the purpose of reducing the intussusception. Experience has shown, however, that such a course is not proper, because it seems to wedge the inner intestine more tightly to the outer one; while by pressing upon the outer surface of the colon just beyond the point to which the inner gut reaches the latter may be readily pushed back until the whole length of intestine is again free. A careful inspection of the cecum, transverse colon and ileum shows that no necrosis and no abrasion has taken place. Had the intussusception remained for twenty-four hours or longer some points of gangrene and some areas of abrasion would surely be discovered. Still later a large portion of the intestine becomes gangrenous. Occasionally such a gangrenous intestine will slough away entirely and be expelled through the rectum, the two portions beyond this segment uniting spontaneously, but much more frequently the condition results in a fatal peritonitis.

Upon inspecting the vermiform appendix we find that it is fourteen cm. long and that it forms a constricting band around the ileum just outside of the ileo-cecal junction. It is likely that when the child had its fall the appendix was thrown around the ileum in this abnormal position and that the constriction caused by the appendix at this point was the exciting cause which produced the invagination.

We will remove the appendix in the usual manner and close the abdominal wound.

During the entire operation there has been but very little manipulation of the intra-abdominal organs, and it seems reasonable to expect that this patient will recover without shock or sepsis.

After-treatment. The patient will be kept quiet, she will be nourished for four days by nutrient enemata, then broth will be given by mouth. Small cleansing enemata will be employed to evacuate the bowel. No cathartics will be allowed for one month. Only such food will be given as can be easily digested without producing much residue.

In cases that come under surgical treatment later, after the intestine has become gangrenous, it is best to excise all of the bowel involved in the intussusception, after the method described for excision of the colon with a part of the ileum.

Frequently by first making an attempt at reduction of the intussusception in late cases the peritoneum is so severely infected that the patient dies of diffuse peritonitis, while he would surely have recovered had these useless manipulations been omitted.

In making this excision it is well to remember that it is even more likely to injure the duodenum in this operation than in the simple excision of the ascending colon, but if the surgeon's attention has been directed to the fact it is not difficult to avoid this complication.

VOLVULUS

Another common condition, which, like intussusception, is characterized by intestinal obstruction, consists of a twisting of the small intestine, the sigmoid flexure of the colon, or, much more rarely, the transverse colon upon its mesentery, thus at once obstructing the passage and destroying the circulation. The twisting of the mesentery gives rise to severe pain.

The closure of the intestine causes nausea and vomiting, the vomitus consisting at first of stomach contents, then mucus and bile, and later more or less decomposed intestinal contents.

The vomiting appears early when the volvulus occurs in the jejunum, later when in the ileum, and quite late when in the colon.

The condition is frequently preceded by a slight fall or by excessive lifting or straining. Occasionally it may be mistaken for an acute gastric disturbance, because of taking some indigestible food, and a few times we have observed patients who imagined that they had taken spoiled food and that they were suffering from ptomaine poisoning.

Several times we have had patients sent to the hospital with a diagnosis of volvulus in whom we found the obstruction due to a small hernia which had not previously been recognized. The fact that the condition had come on suddenly after a slight exertion had given rise to the mistaken diagnosis. In another case the hernia was so slight that it was not discovered until it was located after the abdomen had been opened, when a small portion of one side of the small intestine was found caught in the femoral ring, the obstruction being due to the kinking of the intestine.

Although it is not always possible to make a differential diagnosis between volvulus and acute intestinal obstruction from other causes it is possible to determine the presence of a mechanical obstruction to the intestines, and it does not matter what may be the cause of this condition as the indication for treatment is always the same.

ACUTE MECHANICAL OBSTRUCTION OF THE INTESTINE

Before speaking of the special treatment for volvulus it may be well to discuss the treatment of acute intestinal obstruction, which applies to this condition without regard to the mechanical condition which gives rise to obstruction in any given case.

A statement which should be repeated many times and always regarded when any form of intestinal obstruction is considered, and even when there is the slightest suspicion of the possibility of the existence of intestinal obstruction in any given case, is that it is absolutely unpardonable to give either cathartics or any form of nourishment by mouth. In our experience the mortality has been ten times higher in patients who had been given cathartics before coming into the hospital suffering from intestinal obstruction, than in those who had received none.

It is so absolutely clear that if no food be administered by mouth any case in which there is no mechanical obstruction of the bowels does not need a cathartic because the bowels will move spontaneously if given time and proctoclysis by the continuous drop method, while if mechanical obstruction is present the giving of cathartics will almost certainly kill the patient. In other words in order to prove that a certain number of patients do not have a mechanical obstruction of the intestines one takes the risk, by using cathartics,

of destroying the lives of almost all of those who are actually suffering from this condition.

The reason why it is so dangerous to give cathartics in these cases is because they enormously increase the pressure above the point of obstruction, and consequently the intestine is made more permeable to micro-organisms in its lumen and the increased pressure hastens the occurrence of gangrene of the intestine at the point of obstruction.

As harmful as is the giving of food and cathartics in these cases, so equally beneficial is the opposite form of treatment by means of repeated gastric lavage, which removes a great amount of poisonous material from the alimentary canal and permits the intestines and the stomach to contract. It also prevents the occurrence of inspiration pneumonia caused by the presence of fetid intestinal contents during the operation.

When in doubt in these cases a competent surgeon should operate, although by carefully taking the history and examining these patients an experienced surgeon can almost always make a positive diagnosis.

On the other hand an inexperienced surgeon who is in doubt should continue denying absolutely everything by mouth, should employ gastric lavage and administer normal salt solution by rectum by the continuous drop method until the patient can be gotten into the hands of a competent surgeon.

Operative technique. When it is possible to locate the twisted loop of intestine by the bulging of some portion of the abdominal wall, or by auscultation (the intestinal fluid moving up to a given point and stopping at such point), or by the accurate location of pain or tenderness, it is well to make the incision either in the median line or by splitting either rectus abdominis muscle longitudinally directly over the affected part.

Should the location or the character of the obstruction, or both, not be positively demonstrated before the abdomen is opened it is best to make a median incision if the appendix, the gall bladder or the duodenum are probably not the seat of the trouble; otherwise an incision splitting the right rectus abdominis muscle probably gives the best approach to the diseased part because the location of this condition is twice as frequent in the right as in the left half of the abdominal cavity.

If the intestines are greatly dilated and the patient is in a fair condition the gas and feces should be first evacuated by emptying a small portion of the most prominent loop of the intestine by squeezing the contents in either direction, then having an assistant hold this empty portion between the finger and thumb of each hand, thus preventing its refilling. A circular silk suture is then applied at a point farthest away from the mesenteric attachment of the intestine, then a longitudinal slit is made into the lumen of the intestine two cm. long. A glass tube two cm. in diameter, with smooth ends, and sixty cm. long is inserted into this opening and the edges of the wound are inverted and the suture is tied in a loop so that it can be untied later on. Then the assistant relinquishes his grasp upon the intestine and its contents are permitted to pass out through the glass tube. It is usually impossible to push this tube into the intestines as demonstrated experimentally by Monks, but the intestine can be threaded upon the tube successively until all of the gas and feces have escaped. The intestine is filled and emptied several times with normal salt solution at 100 to 105 degrees F. Then the tube is withdrawn slowly and this portion of the intestine is again grasped by the assistant in order to prevent its refilling and the glass tube is threaded into the opposite end, which is emptied and washed in the same manner. Then the tube is withdrawn and the wound in

the intestinal wall closed, an assistant compressing the bowel at either side to prevent leakage. It is remarkable how quickly the intestine takes on a normal appearance under this treatment, and how well these patients bear the operation.

After the above procedures it is possible to locate the volvulus, because this will be the only portion of the intestine that remains distended. If the intestine is gangrenous or if the mesenteric vessels are thrombosed its excision according to the methods already described is indicated. If the volvulus has not so resulted then the intestine must be untwisted and if there are any adhesions they must be clamped, cut and ligated. If the intestine contained in the volvulus is of considerable length and not gangrenous it is well to leave the glass tube in place and to evacuate the gas and fluid contained in this loop before the intestine is closed. If the volvulus includes the sigmoid flexure or the descending colon it is well to pass a rubber tube up through the rectum and just beyond the loop involved in order to secure drainage and to keep the loop in position until it has been restored from the effects of the torsion. The tube should be composed of fairly pliable rubber to prevent injury from pressure. It is well to have the tube split longitudinally to facilitate its acting as a drain.

Should the patient's condition be very bad it may be best simply to make an enterostomy by bringing up a distended loop, attaching it to the parietal peritoneum, then finding the volvulus, untwisting it, and leaving it in place. This operation in volvulus is so seldom followed by recovery that in almost every case the method described before is preferable.

ACUTE INTESTINAL OBSTRUCTION DUE TO CONSTRICTING BANDS OF ADHESIONS

Here there is usually a history of a previous operation or of peritonitis from any cause. In all other details the history and the clinical symptoms are the same as in volvulus.

The treatment is the same, with the exception that the location of the constricting band is usually in the vicinity of the former operation, or the former peritonitis the origin of which is more commonly the appendix or the Fallopian tube, than from any other points in the abdominal cavity, although we have seen several cases in which the band represented a remnant of the omphalomesenteric duct.

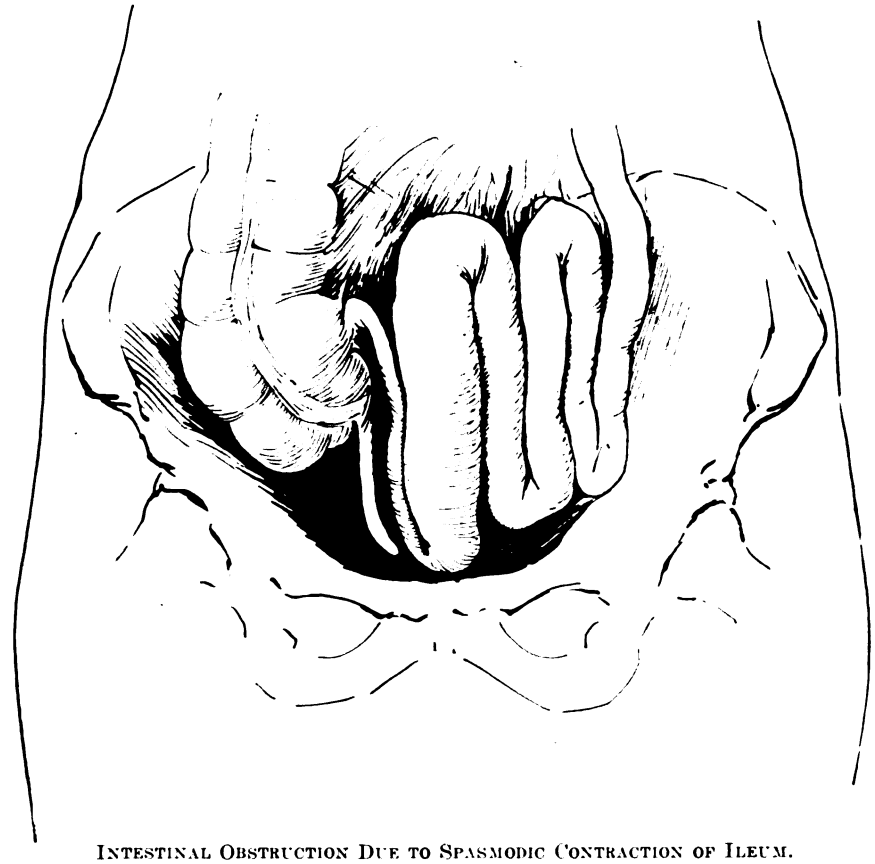
ACUTE OBSTRUCTION DUE TO KINKING OF INTESTINES

This condition can but rarely be differentiated before the operation from that just described as its origin and entire history are the same, and the treatment is identical. The attacks are usually somewhat less acute and less violent and the obstruction is frequently not quite complete.

INTESTINAL OBSTRUCTION FOLLOWING ABDOMINAL OPERATIONS

During the early days of abdominal surgery intestinal obstruction more or less complete in character occurred in a large proportion of cases. This resulted in a number of forms of treatment for this condition. It was found, however, within a few years that post-operative intestinal obstruction is almost always due to errors in judgment, or errors in preparation of patients before

operation, or in surgical technique, or in after-treatment, and that by eliminating these errors it is possible to eliminate post-operative obstruction almost entirely.



INTESTINAL OBSTRUCTION DUE TO SPASMODIC CONTRACTION OF ILEUM.

(We are indebted to Dr. D. N. Eisendrath for the drawing, which was made from one of his cases.)

Intestinal obstruction may be complete as a result of a contraction of a loop of small intestine. This contraction occurs in connection with acute appendicitis and also with pelvic infection and infection of the gall bladder.

In all of these conditions, however, the obstruction subsides if gastric lavage is employed and if neither food nor cathartics are given by mouth, while the patient is supported by the use of exclusive rectal feeding and normal salt solution by rectum or subcutaneously. Cathartics and food given by mouth seem to increase the obstruction.

Errors in preparation. Patients undergoing abdominal operations without having the intestinal canal thoroughly emptied are likely to develop a great amount of gaseous distension of the stomach and small intestine, and this in turn is likely to result in kinking of the intestine which will cause a more or less complete obstruction. By giving two ounces of castor oil in the foam of beer or malt extract on the day previous to the operation, and then giving the patient no food with the exception of broth until the operation has been performed, post-operative obstruction can be eliminated. Of course, this preparatory treatment should never be given in patients suffering from peritonitis or from mechanical obstruction of the intestines.

Errors in technique. Rough or careless handling of the intestines during

the operation, or exposure of the intestines to the air, which is more likely to occur if the intestines are not properly emptied before the operation will result, in many cases, in the post-operative obstruction under discussion. This is especially true if the intestines and omentum are not placed in their normal position after the operation is completed, and more especially if some loops of the small intestine are permitted to become lodged in the pelvic cavity at the conclusion of the operation. The latter cavity should be occupied by the rectum, sigmoid flexure and omentum, particularly in operations upon the female, because if the small intestine becomes lodged in the cul-de-sac of Douglas it is likely to cause bowel obstruction.

Errors in post-operative treatment. The administration of opium, food and cathartics in a patient who has undergone a severe intra-abdominal operation is likely to produce intestinal obstruction. If concentrated, predigested foods and normal salt solution are administered by rectum instead, then in similar patients intestinal obstruction will not result. One of the most important prophylactic measures in post-operative treatment in patients that have undergone abdominal section consists in performing gastric lavage in every case in which there is gaseous distension of the stomach or intestines following operation. This may be repeated from one to three times. In the meantime the patient should be confined to exclusive rectal feeding and to the use of normal salt solution by the drop method. Even in cases in which there is complete obstruction a few days following abdominal operation, the obstruction will practically always subside if this form of treatment is instituted at once. Under no condition should cathartics or anything else be given by mouth in any case in which there are symptoms of post-operative intestinal obstruction.

HERNIA

General considerations. The most common anatomical varieties of hernia, in order of their frequency are: 1. Inguinal. 2. Umbilical. 3. Femoral. 4. Ventral. 5. Hernia of the linea alba.

Among the rarer forms are: ischiatic, pelvic, obturator, lumbar, diaphragmatic, and the various forms of retro-peritoneal hernia, as retrocecal, duodenal, and hernia through the foramen of Winslow.

Clinically hernias are classified as reducible, irreducible, inflamed and strangulated.

Reducible hernia is by far the most common of all varieties. In this form the hernial contents may be returned into the abdominal cavity spontaneously, or when the patient assumes the recumbent position, or by manipulation by the patient or physician.

In the early stages of development practically all hernias are reducible. Later on, from the constant irritation, in a considerable proportion of cases, the hernial contents become adherent to the sac, making it impossible to effect a complete reduction. This is especially apt to happen in cases of umbilical hernia.

In other instances the hernial sac is large and the neck of the sac is comparatively small, so that considerable effort is required to accomplish the reduction. In many cases in which it seems almost impossible to replace the hernial contents when the patient is in the ordinary recumbent position, reduction may be accomplished with ease after placing the patient in the Trendelenburg position.

The hernial sac. With the exception of some of the rarer forms of hernia, such as diaphragmatic and retroperitoneal, there is one feature common to all, and that is the sac. This sac is composed of a layer of peritoneum which covers either a portion or the entire contents of the hernia. The sac is originally a

very thin membrane, but may undergo marked changes in cases of long standing and in those in which an ill-fitting truss has been worn for a long time. In such the sac may become markedly thickened, very tough and of leathery consistence.

In the congenital form, the hernial sac is a preformed pouch of peritoneum which remains empty until some unusual effort or accident causes an increased intra-abdominal pressure, which forces some of the abdominal contents into this pouch.

In the acquired variety the parietal peritoneum is forced by intra-abdominal pressure through some congenital defect in the abdominal wall.

In oblique inguinal hernia the sac always bears a certain relation to the spermatic cord. It is always found in a position anterior to the cord and the spermatic vessels, and is surrounded, together with the latter, by the thin layer of infundibuliform fascia. In inguinal hernia in the female the sac bears the same relation to the round ligament as to the cord in the male and is very closely attached to it.

There are some conditions in which the hernial sac may be incomplete, such as sliding hernia of the sigmoid, cecum and occasionally of the bladder. In such cases the anterior portion of the sac is formed of peritoneum and the posterior portion is continuous with the wall of the sigmoid, cecum or bladder, whichever one may be involved. Clinically it is important to bear this condition in mind, in order not to injure the intestinal wall on attempting to open the hernial sac.

It is clear that a sliding hernia can occur only in case of an intestine which is not completely surrounded with peritoneum. Were the peritoneum constantly normal in its arrangement, sliding hernia of the ascending and descending colon into the inguinal or femoral canals only would be possible, but this is not the case, because the cecum and the sigmoid are not always completely surrounded with peritoneum. Whenever the sac cannot be readily isolated, the possibility of the presence of this condition must consequently be constantly borne in mind to prevent injury to the intestine.

In these cases as much as is present of the sac should be preserved in order that the peritoneal defect may be corrected in the intestine before the latter is replaced in the peritoneal cavity, so that there will in the future be a fairly good mesentery.

The remaining steps of the operation differ in no way from those usually taken in the closure of a hernial opening after the sac has been ligated and removed.

In direct inguinal hernia in the male the hernia descends below the epigastric vessels and out through the external ring. It pushes the cord directly in front of it, or to one side, but does not bear such a definite and intimate relation to the cord as is found in oblique inguinal hernia. The sac is not so liable to descend into the scrotum as in oblique inguinal hernia, but is more likely to take an outward direction.

The size and shape of the sac in inguinal hernias vary greatly. In scrotal hernia the sac is most often pear-shaped.

It is not uncommon to find a constriction at about the center, forming an hour-glass shaped sac. The sac is also frequently sacculated, and occasionally to such an extent that a complete double sac is formed.

Varied contents of the sac. The contents of the hernial sac also varies greatly. Nearly every organ in the abdominal cavity has been found to form a part or the whole of the contents of the sac. The most frequent contents are the omentum and small intestine, then some portion of the large intestine, and next the bladder. In femoral hernia the intestine rarely forms any portion of the contents except in cases of strangulation. Various portions of the

small intestine may be caught in the hernial sac, but the portion most frequently involved is a loop a short distance above the ileo-cecal valve, which has a longer mesentery than the other portions of the small intestine.

The edge of the bladder is quite frequently found in the sac in inguinal hernias and occasionally a diverticulum or pouch of the bladder forms a considerable part of the sac and also of its contents. This is most frequent in patients who are rather obese and in whom there is a diffuse bulging over the inguinal canal, instead of having a pear-shaped sac descending into the scrotum.

The appendix has been found many times in the sac of inguinal hernia, and R. E. Webster has reported a case of strangulated left inguinal hernia in which a Meckel's diverticulum constituted the contents of the sac.

The ovary and tube together, or the ovary and tube separate, have frequently been found both in femoral and inguinal hernias, and a hernial sac containing the uterus has been reported a few times.

Etiology of hernia. Oblique inguinal, umbilical and femoral hernia occur at points which are naturally weak because of the normal opening through the abdominal wall during fetal life. In many cases of oblique inguinal, and in some of the umbilical variety, these openings have never been closed, so that the hernia is in consequence congenital.

The theory that oblique inguinal hernia is primarily always due to an incomplete closure of the processus vaginalis testis is being accepted by many surgeons. This is due largely to the teachings of Mr. Hamilton Russell, of Melbourne, concerning the "saccular" theory for the etiology of hernia. In accepting this theory, it does not mean that every individual with an incompletely obliterated process must develop a hernia, but the occurrence depends secondarily upon the various conditions usually enumerated as the exciting and predisposing causes of hernia.

Frequently the tissues around the hernial opening are much weaker than normal, so that they will give way much more easily. This is true especially in patients who have one or both parents with a similar defect. (More than one-third of all patients suffering from hernia give a history of hereditary tendency in this direction.)

The fact that the spermatic cord passes through the inguinal canal makes this form of hernia most frequent. A long omentum with its ability to become insinuated in any opening, however small it may be, is a common predisposing cause in the formation of hernia. The same is true of a long mesentery.

The presence of a great quantity of fat in the abdominal wall markedly weakens this structure, first, from the fact that lobes of fat will invade the natural openings and separate the connective tissue and muscular layers whose function it is to prevent the formation of hernia; secondly, because with the accumulation of great quantities of fat in the connective tissue spaces of the abdominal wall the muscles themselves become softened on account of a certain amount of fatty degeneration which takes place in these tissues. Moreover, at the same time there is always a corresponding increase in the amount of fat within the abdominal cavity, which not only favors the formation of hernia because of its weight, but also because it increases the intra-abdominal pressure.

Exciting causes. The chief exciting cause is increased or abnormal intra-abdominal pressure. This may be very violent and of only short duration, as in lifting heavy weights, falling a great distance or with very great force, violent coughing or sneezing, etc. In such cases the tissues are virtually torn, making an opening through which the hernial contents protrude. Again, the abnormal intra-abdominal pressure may be less violent and more continuous, as where there is a long-continued cough, chronic constipation, or an obstruction of the urethra on account of phimosis, stricture, enlargement of the

prostate gland or stone in the bladder. The same is true of gaseous distension of the stomach and intestines due to digestive disturbances. Adhesions following peritonitis due to appendicitis, or infection through the Fallopian tubes, is likely to have the same effect. In short, anything which may cause abnormal intra-abdominal pressure, either acute or chronic, is likely to bring about the formation of a hernia, especially if there is a predisposition thereto.

General treatment. In many of these cases a properly-fitting truss will secure for the patient a relative degree of comfort and safety, but necessitates the wearing of an apparatus which is at best unpleasant and, in summer especially, annoying, uncomfortable, fatiguing and sometimes painful. Aside from this the patient is constantly exposed to the risk of having strangulation, which is, under all circumstances, very dangerous, and quite a considerable proportion of all persons suffering from hernia lose their lives sooner or later as a result of this sequel. Many persons suffering from hernia find it difficult to compete with others of their rank and qualifications because of this handicap.

Pre-operative management. In a general way the preparatory treatment is the same for these patients as for those about to undergo any other serious operation, with the addition, it may be, of certain steps which are intended to eliminate as much as possible some of the predisposing causes.

It is well, for instance, to place patients who have a great accumulation of fat in the abdominal wall upon a systematic course of treatment for the reduction of this fat, if possible, before operation is done. We have usually employed the following diet with excellent results, the patient losing from three to ten pounds per week; the general appearance and strength improving constantly during this treatment. Many have lost a total of from thirty to sixty pounds in weight, and in a few very obese patients the loss has even exceeded one hundred pounds.

The diet may be varied to suit the individual case.

DIET LIST

Breakfast.—
Tea—4½ oz.—A very small cup.
Milk—2/3 oz.—One and a half tablespoonsful.
Sugar—75 grs.—A small lump.
Bread—375 grs.—A very small slice.

Dinner.—
Sour wine—3 1/3 oz.—A wineglassful.
One egg, or lean meat—10 oz.
Lettuce with vinegar—1 2/3 oz.
Vegetables—1 2/3 oz.
Bread—375 grs.

Supper.—
Wine—½ pint.
Water—½ pint.
Quarter small chicken, or 8 oz. lean meat.
One egg.
Bread—375 grs.

In order to make the plan clear to the housekeeper who supplies the meals we give each patient the following pointed directions:

DIET

Kindly follow this list carefully. There will be three breakfasts, three luncheons and three suppers any one of which you may choose, but you must never eat more than is contained in any one of these meals. In place of any

one of these meals at any time you may substitute one pint of buttermilk if you like.

Breakfast.—

No. 1. One soft-boiled egg, one small piece of toast.
No. 2. Half a pound of lean steak, one baked apple.
No. 3. Half a pint of hot milk and one small piece of bread.

Luncheon.—

No. 1. Half a pint of soup and one small piece of bread.
No. 2. Half a pound of fresh fish, broiled, one dish of lettuce with pepper, salt and lemon-juice.
No. 3. One pint of buttermilk and one small piece of bread.

Supper.—

No. 1. Half a pound of beef, one dish of spinach, or one dish of turnips, or one dish of boiled onions.
No. 2. Half a pound of lean mutton, one dish of cabbage, or one dish of cauliflower, or of squash.
No. 3. Half a breast of chicken, one dish of lettuce with pepper, salt and lemon-juice, or fruits cooked without sugar, or one dish of cooked vegetables, or one glass of fruitjuice.

You should drink nothing at all during your meals, nor for one hour before or after eating. No water, tea, coffee or fluids of any kind. Between meals you may drink water, either hot or cold, flavored with lemon or orange juice. Take absolutely nothing containing alcohol.

Take breathing exercises regularly morning and evening. Take a walk out of doors every day. Increase the length of your walk gradually, and also the speed.

These meals may be changed about to suit the inclination of the patient. It is quite as well to take the food prescribed for lunch at breakfast time, and *vice versa*. Men who are in business frequently find the breakfast insufficient, and the bread may then be omitted and eight to twelve ounces of lean steak substituted.

Drink nothing during the meal, nor for an hour before or after, except as given in the above list. When thirsty during the day drink a little sour wine or sour lemonade.

Aside from this the patient is advised to walk systematically, beginning with that which is perfectly comfortable on the first day and increasing it one-fourth mile daily until the distance reaches from six to twelve miles. At first the habitual speed of walking should be practised, but this should be increased until the patient covers the entire distance at a maximum speed for his strength. During this walk he should breathe very deeply through the nose, the lips remaining closed.

Other hygienic measures like hot-baths followed by cold shower, massage and various gymnastic exercises may be added to this plan.

All this will not only reduce the amount of fat in the abdominal wall, but also to a great extent in the omentum and mesentery and underneath the peritoneum, thus reducing the intra-abdominal pressure to a marked degree, and at the same time increasing the firmness of all the tissues in the vicinity of the hernia.

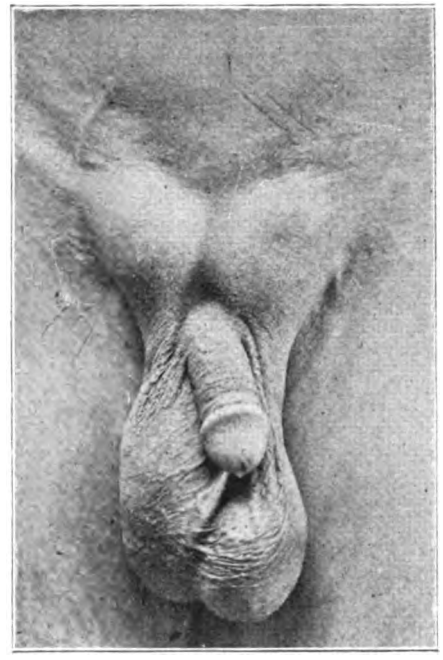
If there is an abnormal amount of intra-abdominal pressure due to gaseous distension of the abdomen caused by indigestion this should be corrected. The same is true of constipation, or obstruction to the passage of urine, or a chronic bronchitis. In short, so far as possible, it is wise to eliminate the predisposing causes of hernia before the operation for radical cure is undertaken.

The same rules should be borne in mind in the after-treatment. Provi-

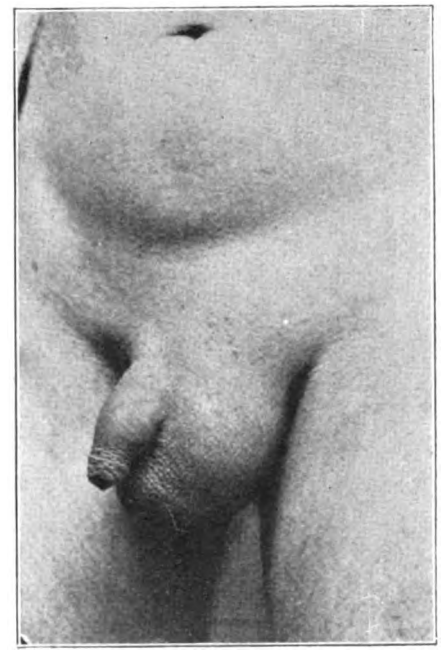
sion should be made against the recurrence of these predisposing causes after the patient has once been relieved of his hernia by an operation.

INGUINAL HERNIA

Typical case. Our patient is thirty-eight years of age and a farm-laborer by occupation. One sister died at eighteen and one brother at twenty years of age. His mother suffered from a rupture. Patient had whooping cough in childhood and typhoid fever at eighteen; was weakly and ill most of the time until the age of twenty. He had pneumonia at the age of thirty-three. At the age of thirty patient felt some pain in both inguinal regions, after climbing a tall tree. One week later he jumped suddenly out of bed, when he experienced a pain in the left inguinal region. At this time he noticed a small bulging over the left inguinal canal. He wore a truss for three years, when he was apparently cured. At this



TYPICAL BILATERAL INDIRECT OBLIQUE INGUINAL HERNIÆ.



INDIRECT OBLIQUE INGUINAL HERNIA DESCENDING INTO THE SCROTAL SAC. TREATMENT—HERNIOTOMY.

time he suffered from pneumonia, coughed a great deal, and when he had recovered from this sickness found that the hernia had returned. He again wore a truss, which retained the hernia, but the hernial opening showed no further tendency toward closing.

Three weeks ago, after patient had been working hard in the field, he noticed a slight bulging on the right side, which has increased constantly until it has now attained the size of a hen's egg. Neither hernia has caused pain. There has been no tendency towards strangulation. When the patient is in a recumbent position the herniæ always reduce spontaneously.

The patient is fairly well nourished. Lungs, heart, kidneys and abdominal organs are normal; the tongue is slightly coated; appetite good; bowels regular.

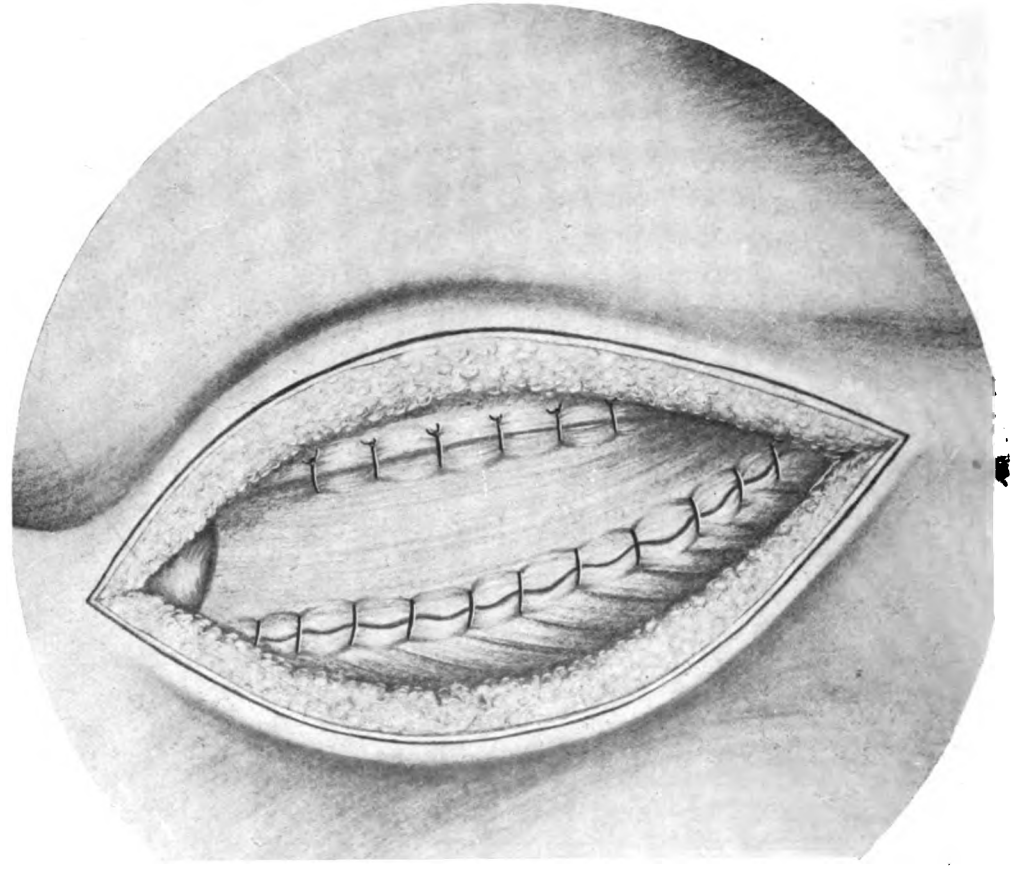
The abdomen is normal except for a marked weakening over both internal abdominal rings, causing a bulging the size of a hen's egg over each inguinal canal when the patient is in the erect position, and this is still further exaggerated upon coughing. The enlargement is a little more marked upon the right side. Patient complains of a feeling of weakness at this point in the abdominal wall and he is compelled to support it with his hand when he attempts to lift any weight. The right inguinal canal easily admits the tips of two fingers; the left the tip of one finger only.

The contents of the canal can be easily reduced into the abdominal cavity by means of

a slight amount of pressure, and upon taking the recumbent position the bulging disappears at once.

All of the conditions are so clear that there can be no difficulty in making a diagnosis of uncomplicated double inguinal hernia.

Differential diagnosis. It is almost impossible to make a wrong diagnosis in simple cases of reducible inguinal hernia, but it is quite different if some complication exists. The most common of these consist of adhesions. If



BASSINI'S OPERATION FOR INGUINAL HERNIA WITH IMBRICATION OF STRUCTURES AS ADVISED BY DR. E. WYLLYS ANDREWS.

some of the hernial contents, such as the omentum or intestine, are adherent to the hernical sac, or if the hernia is complicated by an acute inflammatory condition, it may be mistaken for an inflammation of the inguinal lymphatic glands.

The latter condition is, however, usually preceded by an infection of the urethra or the prepuce, or of some portion of the lower extremity such as may come from an infected corn or from some slight abrasion of the skin.

If the hernia has extended down into the strotum it may be difficult to differentiate it from hematocele or a hydrocele, although one can usually see rays of light shining through the latter by placing a small tube against the scrotum and holding a light on the opposite side. Moreover, by grasping the tissues opposite the external abdominal ring between the finger and thumb one can always feel the tissues of the cord above a hydrocele, but not above a hernia, except in children suffering from an irreducible hydrocele of the cord, to be considered later. On the left side a large varicocele is sometimes mistaken for hernia and *vice versa*. This, however, should not occur, because the enlarged veins have a peculiar, wormlike feeling in varicocele, which may be easily recognized.

Occasionally an inguinal hernia and a femoral hernia occur in the same patient, and in a few cases, instead of extending in the direction of the inguinal canal into the scrotum an inguinal hernia will descend to the upper portion of the scrotum and then be deflected outward to a point opposite the femoral ring, and thus have the appearance of a femoral hernia.

In a similar manner a femoral hernia, instead of descending after protruding through the femoral opening, may extend upward and form a swelling in the region of the inguinal canal and thus have the appearance of an inguinal hernia. So long as the hernia is reducible in either case the diagnosis can readily be made, because the opening through which the hernia has protruded can be demonstrated by digtal examination; if this is above Poupart's ligament it is an inguinal, if below, a femoral hernia.

Tumors are very rare in the region of the inguinal canal, but we have seen a lipoma and several sarcomata which had been diagnosed as inguinal hernia.

Etiology. There can be no doubt but that there is an hereditary tendency in many families to the formation of hernia. If both parents in a family suffer from this defect some of the children are almost certain to be afflicted in the same manner. The well-known fact that special defects in families are likely to be inherited is shown in this disease. There is a much larger proportion of herniæ in nationalities in which intermarriage between first cousins is freely practised than in others in which this is forbidden.

The natural opening in the inguinal canal in the male, due to the descent of the testicle, makes the occurrence of inguinal hernia much more common than in the female.

Long-continued, exhausting diseases cause a relaxation of the tissues of the abdominal wall, which predisposes to the formation of hernia.

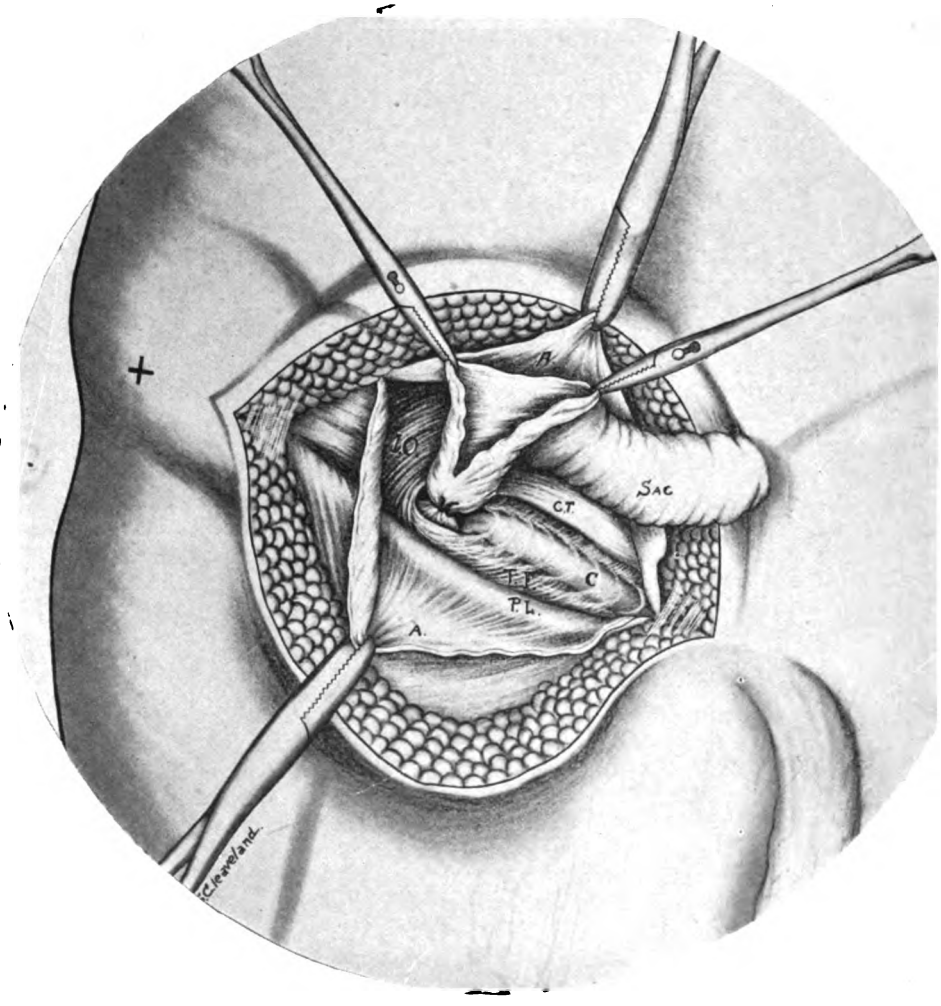
In a considerable proportion of cases the inguinal canal had never been completely closed after the descent of the testicle, and it required only a slight dilatation of the internal abdominal ring, followed by a sudden increase of pressure, to force down some of the intra-abdominal contents, and the hernia is thus established. A long, thin omentum greatly favors this last step.

Indications for operation. In our typical patient the hernia can be readily reduced and retained by means of a truss, hence the conditions are very similar to those discussed in connection with femoral hernia. We can undoubtedly relieve this patient of the discomforts of wearing a truss, and the dangers of a possible strangulation, by a safe operation, which will disable him for work not longer than one month. There can consequently be little doubt concerning the wisdom of his choice of treatment.

Preparation for operation. The intestinal canal should be thoroughly emptied by the administration of two ounces of castor oil the day before operation, followed by a large soap and water enema that evening and another early the morning of operation. The field of operation should be shaved the evening before and the following morning the patient should take a hot soap and water tub bath. As soon as the patient is anesthetized the skin area is

washed thoroughly with soap and water (being careful not to cause irritation), then it is washed with 1 to 2,000 bichloride solution, then with alcohol. The surface is dried and painted with full-strength, compound tincture of iodine.

Operative technique. An incision ten to fifteen centimeters in length is made in the direction, and over the center, of the inguinal canal, beginning at



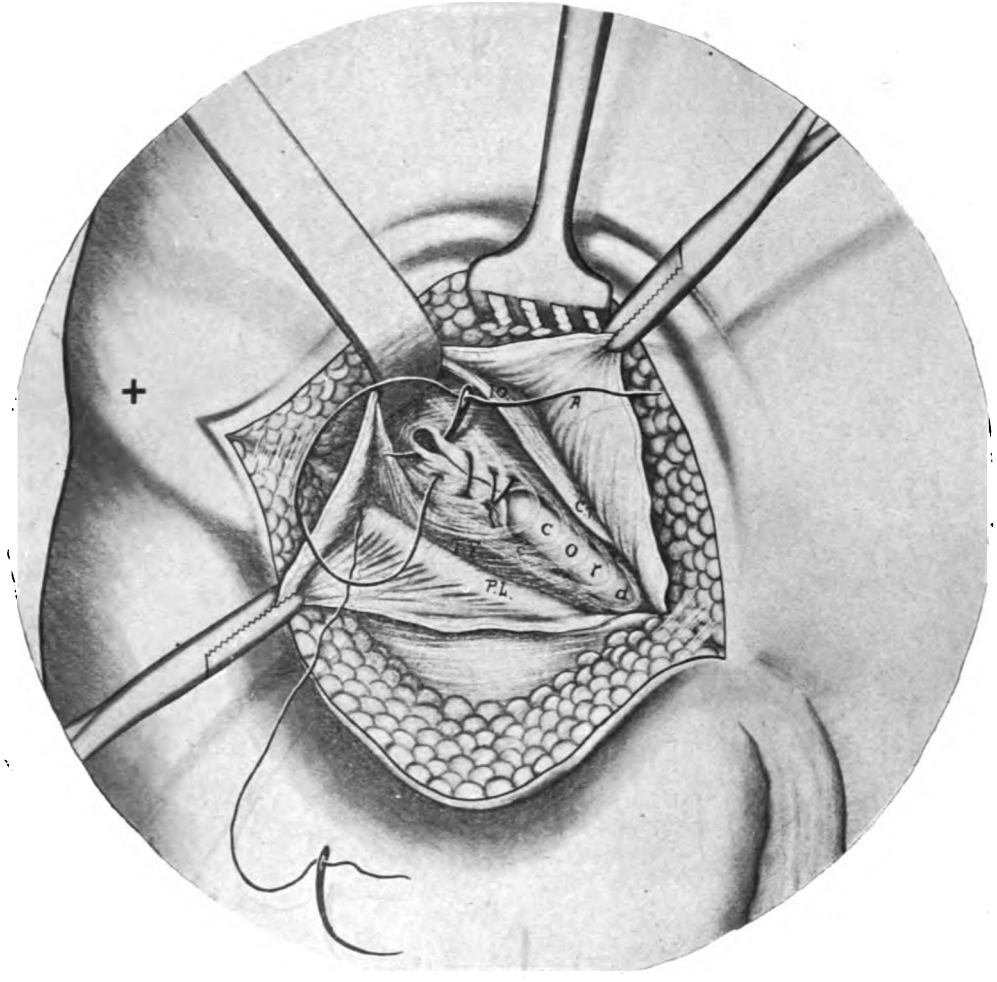
FERGUSON'S OPERATION FOR INGUINAL HERNIA.

T. F., transversalis fascia; I. R., internal ring; P. L., Poupart's ligament; I. O., internal oblique muscle; A, aponeurosis of the external oblique muscle; C, cremaster muscle; C. T., conjoined tendon.

a point two centimeters above the scrotum. This is carried through the skin superficial fascia and fat, exposing the fascia of the external oblique abdominal muscle with the hernial sac protruding at the lower end of the inguinal canal.

The fascia of the external oblique is now slit up in the direction of the inguinal canal to a point five centimeters above the internal abdominal ring. The edges of this are now carefully retracted, and the soft tissues, consisting of fat, portions of the cremaster muscle and connective tissue, are carefully

dissected away, leaving the anatomical structures plainly exposed. The fat can be removed most perfectly and rapidly by stripping between the layers of a piece of moist gauze held between the fingers and thumb. This exposes the ledge of Poupart's ligament and the fascia of the external oblique below, the internal oblique and transversalis fascia and the fascia of the external



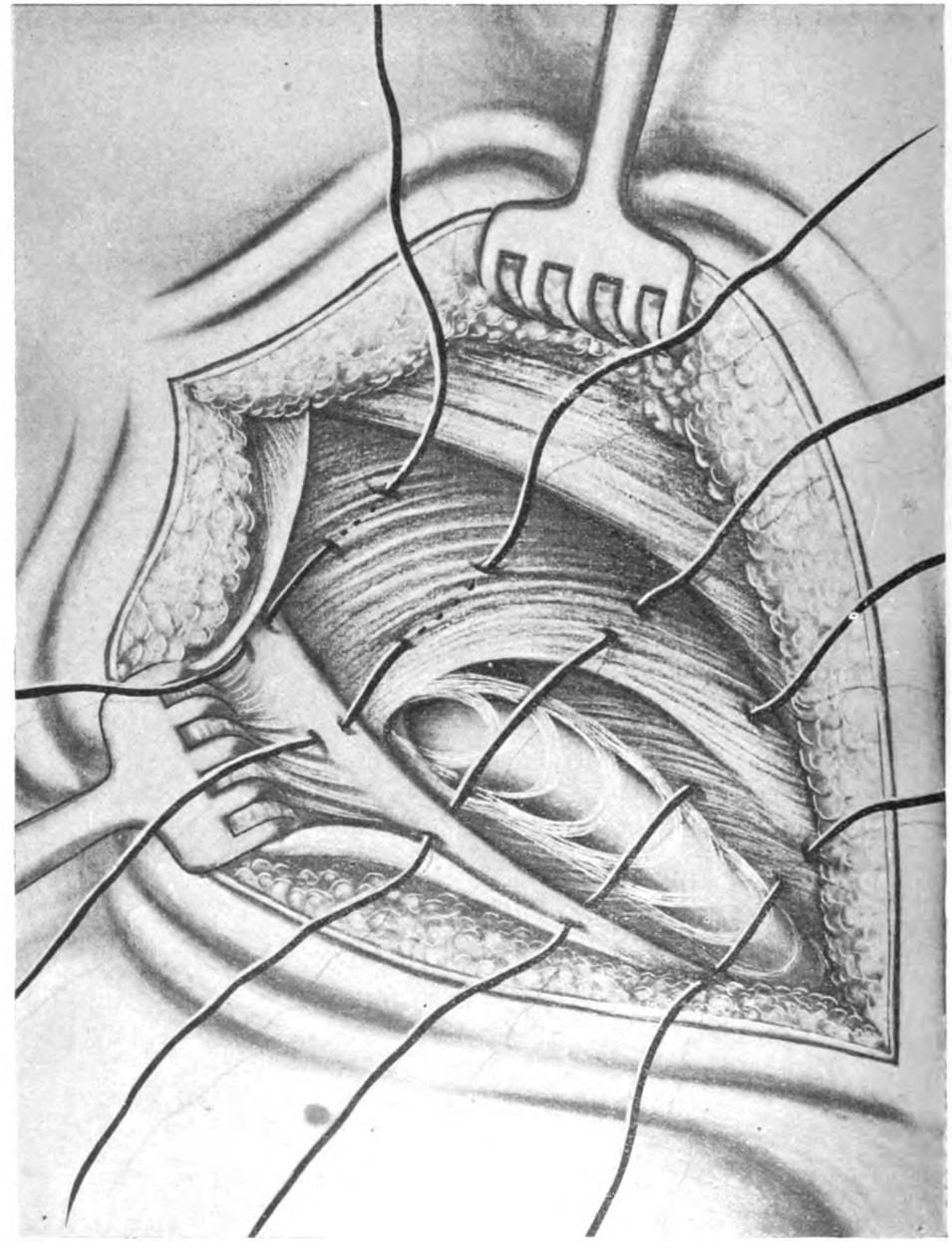
FERGUSON'S OPERATION FOR INGUINAL HERNIA.

A, aponeurosis of the external oblique muscle; P. L., Poupart's ligament; I. O., internal oblique muscle; T. F., transversalis fascia; C, cremaster muscle.

oblique above, and between these the hernial sac and the spermatic cord; and to the outer side, the fibers of the internal oblique.

The hernial sac is now carefully dissected out, caution being taken not to injure the tissues of the spermatic cord, which in this case we find continuous with the upper portion of the sac, showing that we have to deal with a congenital hernia, the tunica vaginalis having remained open since birth, the internal ring, however, being so nearly closed that there was no protrusion of omentum until many years later.

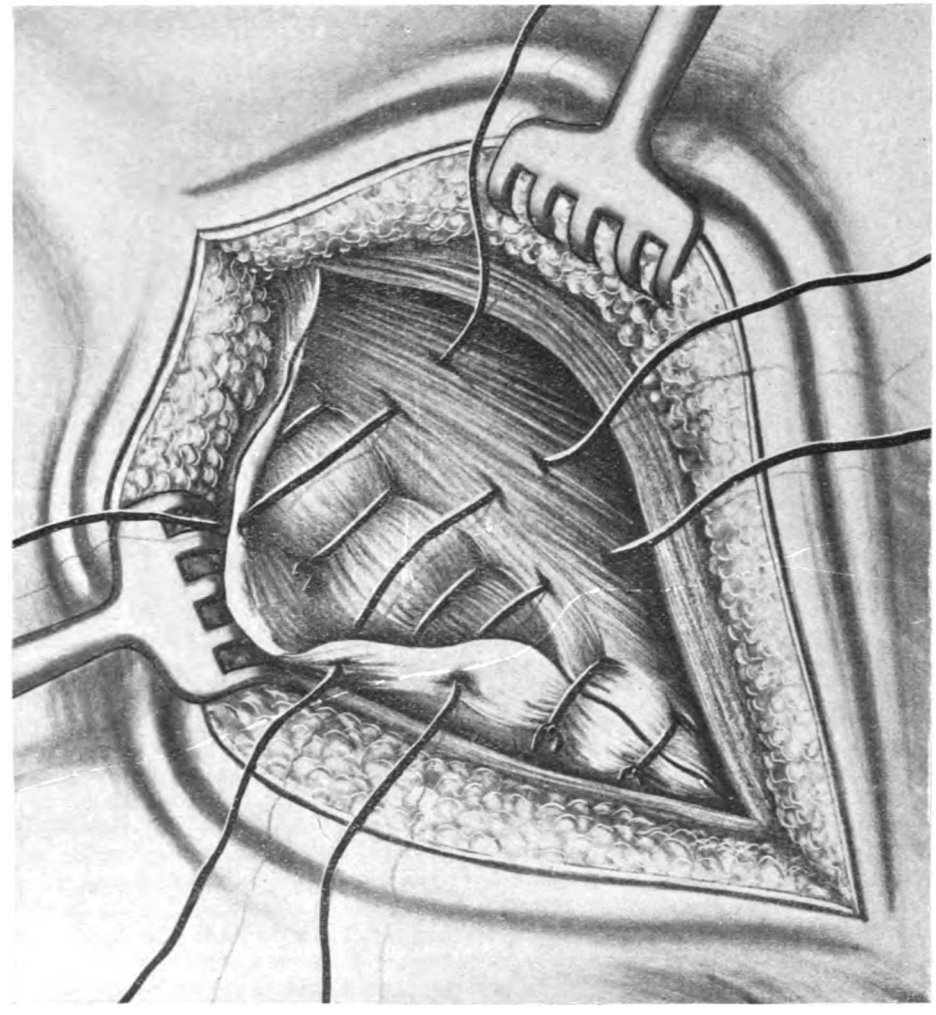
In order to facilitate the separation of the upper portion of the sac we will open the latter. It contains a long, thin portion of omentum. This is drawn down gently as far as it will come without using any force. It is spread



FERGUSON'S OPERATION FOR INGUINAL HERNIA.

out and the vessels are ligated by passing around them catgut ligatures at each point at which they can be seen by holding up the spread omentum to the light. Then the omentum is cut away beyond these ligatures, preserving

enough tissue to prevent slipping. The sac is now dissected up to a point quite within the abdominal cavity; it is then transfixed with a needle carrying a double catgut ligature and tied so as to prevent slipping. The sac is cut away, care being taken to leave enough tissue to prevent the slipping of the



FERGUSON'S OPERATION FOR INGUINAL HERNIA.

With deep sutures tied uniting internal oblique abdominal and transversalis muscles and conjoined tendon to Poupart's ligament. Showing the fascia of external oblique abdominal muscle; conjoined tendon; internal oblique abdominal muscle. The untied sutures show the method of overlapping,—Andrews' imbrication principle as applied to Ferguson's operation.

ligature. The stump is now retracted within the abdominal cavity by the elasticity of the peritoneum.

The steps which have just been described are exceedingly important, especially the careful removal of the soft tissues, the hernial sac and the omentum, because neglect of any one of these points would tend to cause a recurrence.

The internal oblique muscle and transversalis fascia are now carefully united with interrupted sutures of chromicized catgut to the ledge upon the

under surface of Poupart's ligament, the edge of the fascia of the external oblique being carefully retracted.

In applying these sutures, it is well to bear in mind the possibility of injuring the deep epigastric vessels by carelessly grasping the tissues above with the stitch, or the iliac vessels below in the same manner. The simplest way to avoid injuring the latter is to insert the needle through Poupart's ligament from within outward.

The fascia of the external oblique muscle is then sutured. The skin is then sutured over all.

This method, known as Ferguson's operation, has the advantage of closing the inguinal canal perfectly, firmly and permanently, and at the same time leaving the tissues of the spermatic cord undisturbed.

Since the publication of this method by Ferguson we have used it because it combined all of the good qualities of Bassini's operation, which we had practised with most excellent results for a number of years previously, and has the advantage of being simpler in that it does not disturb the tissues of the spermatic cord.

In order to illustrate the latter method, however, especially as it is the one still in use by most of the best surgeons, we will perform Bassini's operation upon the other side. For the sake of simplicity, we can make use of the illustrations just shown of a herniotomy upon the left side, because all the steps, with one exception, are identical.

The incision, the exposure of the anatomical layers, the removal of the soft tissues and the hernial sac are the same. In the last step, however, we find this difference: The sac is not continuous with the tissues of the spermatic cord, but is simply adherent by means of delicate fibers of connective tissue, showing that on this side we have an acquired and not a congenital hernia.

We also find that the sac contains no omentum. It is likely that this descended into one side occasionally and then into the other, or the other side may have contained omentum and this side intestines regularly. Having disposed of the hernial sac as before, we make the step in the operation in which the two methods named differ. The tissues of the spermatic cord are carefully loosened from all of the surrounding tissues. Then we elevate it from the floor of the inguinal canal by means of a blunt hook and insert the stitches of chromicized catgut. These stitches are applied precisely as before, grasping the same tissues, two of them being applied above the cord and the others underneath the elevated cord, so that the latter passes out between the second and third stitch, counting from the outer side. Six stitches will usually suffice. They may be applied with greater regularity if they are not tied until all are in place. The same care must be taken to prevent the injury of the deep epigastric and iliac vessels as before.

The two stitches above the cord are of the greatest importance, because it is at this point that recurrence is likely to take place. After these stitches have been tied the fascia of the external oblique muscle and the skin are sutured as before.

Variations in technique. Occasionally the tissues to the inner side of the inguinal canal are so attenuated that it seems difficult to secure a permanent closure of the hernial opening. In this event it may become necessary to utilize the rectus abdominis muscle—Bloodgood's method. The fascia covering the outer edge of the rectus abdominis muscle is split longitudinally and the muscle is then sutured to Poupart's ligament, together with the conjoined tendon of the internal oblique and transversalis.

Prognosis. Both of these operations, if performed with great care, will result in a permanent cure of inguinal hernia in almost every case, provided

that the patient prevents for the future the recurrence of abnormal intra-abdominal pressure.

In the female patient the operation is done precisely in the same manner, with the exception that the round ligament, which corresponds to the tissues of the spermatic cord, is practically disregarded.

FEMORAL HERNIA

Clinical case. An unmarried woman, twenty-eight years of age, a servant by occupation, gives the following history:

Her parents, brothers and sisters are well. She was well and strong as a child; menstruation since the age of sixteen, regular and normal. She has worked hard as a servant since the age of twenty. At twenty-two she first noticed a slight protrusion in the region of the left femoral canal. This has increased gradually. It is now the size of a hen's egg. She can reduce it readily, but suffers from a dragging pain when working hard; in fact, even when she is compelled to stand or walk she is very uncomfortable.

She is well nourished, the various organs are normal, both as regards their anatomical position and physiological functions. Upon standing a swelling develops in the left femoral region to the size of a hen's egg. The swelling disappears instantly upon resuming the recumbent position, and an opening that will admit the tip of a finger can be felt under Poupart's ligament. There is an impulse upon coughing or straining.

The history and physical examination leave no doubt as to the diagnosis. It is an uncomplicated case of femoral hernia.

Differential diagnosis. If a portion of the omentum becomes attached to the lining of the hernial sac, on account of inflammatory adhesions, it may occasionally be mistaken for lymphadenitis of the glands often found in this region.

Lipoma has been mistaken for femoral hernia; the same is true of sarcoma. All of these conditions can, however, be eliminated in this case because there is a definite femoral canal when the swelling is reduced, and there is a distinct impulse upon coughing or straining. Moreover, the condition is too chronic for either sarcoma or lymphadenitis.

The history is interesting from one point alone, which probably explains the origin of this hernia.

Etiology. So long as this patient remained at home and simply performed her share of the duties in the household of her parents, who were working people with a small income, she remained perfectly well. She went into service as a domestic and was compelled to labor beyond her strength, and consequently soon became relaxed. When she lifted heavy wash-boilers, and overexerted herself in other ways, immediately the point of weakness in her femoral region became apparent. The peritoneal protrusion formed a hernial sac and as the omentum or intestine was forced into this sac the latter slowly increased, until it acquired its present size.

Femoral hernia is almost always acquired at a time when the patient is exposed to an abnormal strain, most commonly during the child-bearing period or, as in this case, during a time of hard domestic service.

The treatment may be palliative, by means of a truss which could undoubtedly be adjusted, or curative, by means of an operation.

There are no strong indications in this case. Her suffering is not severe, she is not disabled for work, nor is she in great danger of becoming worse. The only danger is from strangulation, and this is not great, because the opening through which the hernial contents enter the sac seems to be sufficiently large to permit an easy reduction. Should there develop a more marked disproportion between this part and the remaining portion of the sac, strangulation would be more likely to occur. Whatever is done for this patient is consequently not a matter of necessity, but one of choice.

Although a truss would probably retain this hernia, it is not to be chosen

lightly, for it will be a hardship for this patient to be subjected to the discomfort of wearing this very uncomfortable instrument for the remainder of her life. Moreover, such a course would be connected with considerable expense. Trusses have to be changed and repaired and are never comfortable to wear.

On the other hand, in choosing an operation for this condition we must be reasonably certain of three things, viz.: 1. It must be almost absolutely safe. (This patient is now in good health and is likely to remain so for a long time if no operation be performed, therefore we take a great responsibility in advising an operation if it is not safe.) 2. The result must be permanent. 3. The patient must not be disabled for work for too long a time.

It is believed that all of these conditions may obtain under right management.

The ordinary preparations of the patient in general and of the field of operation are made.

Operative steps. An incision is made over the most prominent portion of the swelling, either parallel with the axis of the body or with Poupart's ligament. The center of this incision should be over the middle of the femoral canal.

After the skin and superficial fascia have been severed it is best to lift the underlying tissues by means of two pairs of dissecting forceps, in order to protect each successive layer of tissue. This will greatly facilitate the operation and at the same time increase the safety to the patient.

It is usually not difficult to recognize the sac on account of its smooth, hard structure, but if the tissues have been severely irritated by pressure from a truss it then is often more difficult. It can, however, always be recognized after it has been opened on account of the smooth peritoneal lining and usually there is an escape of hernial fluid as soon as the sac is incised.

If the sac is recognized before opening it should be carefully separated from the surrounding tissues to a point quite within the femoral ring. It should then be opened to determine its contents. If it contains intestines, these should be replaced into the peritoneal cavity; if omentum which has lost its normal qualities from irritation caused by its confinement in the hernial sac, it is well to grasp this with forceps and draw it down until a slight amount of resistance indicates the fact that all of that portion which has occasionally descended in the hernial sac has been drawn down. If the amount is considerable it should be ligated in a sufficient number of portions to prevent its being tied in a mass large enough to cause irritation by its presence in the abdominal cavity.

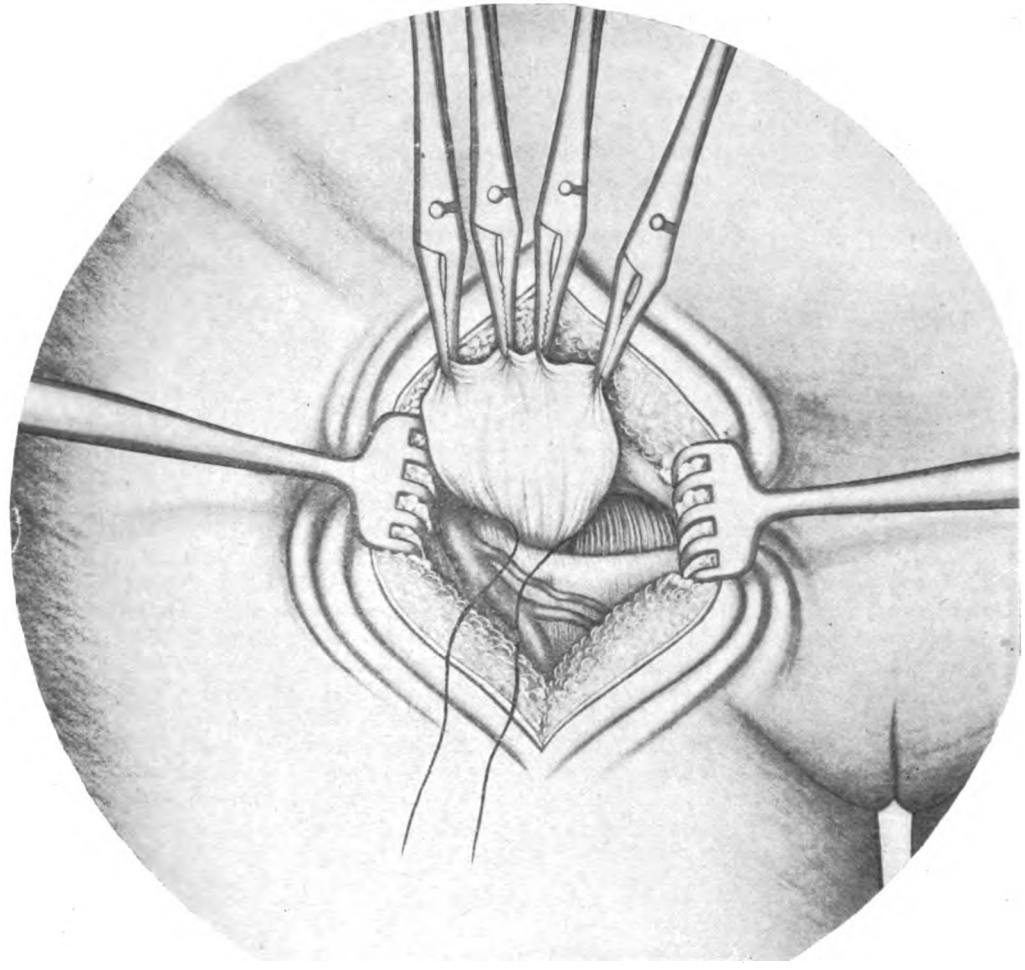
The ligatures should consist of catgut or fine silk, which should be applied just tightly enough to control the hemorrhage, but not sufficient to crush the tissues. It is well to tie three times if catgut is used, because the peritoneal fluid has a tendency to soften this material and cause the knot to loosen. The portion beyond the ligatures is cut away, care being taken to leave enough tissue to prevent slipping. For the same reason great care must be used in replacing the stump.

It is important to dispose of the long, thin portions of omentum in this manner, because if left undisturbed they are likely to become insinuated in any slight depression which may be left in the abdominal wall at the point of the operation and hence predispose to recurrence.

The hernial sac is then grasped by means of hemostatic forceps and drawn out of the wound as far as possible without tearing it loose, as shown in the accompanying plate. It is then ligated as highly as possible with catgut or fine silk. It is best to transfix the neck of the sac with the ligature mounted upon a needle, and tie first to one side and then to the other, so as to

prevent slipping of the ligature when the pedicle is dropped. A sufficient portion of the sac should be left outside of the ligature to prevent slipping, as shown in the accompanying figure.

When the sac has been cut away the stump will retract within the peritoneal cavity and the ring be left without a lining.



FEMORAL HERNIA.

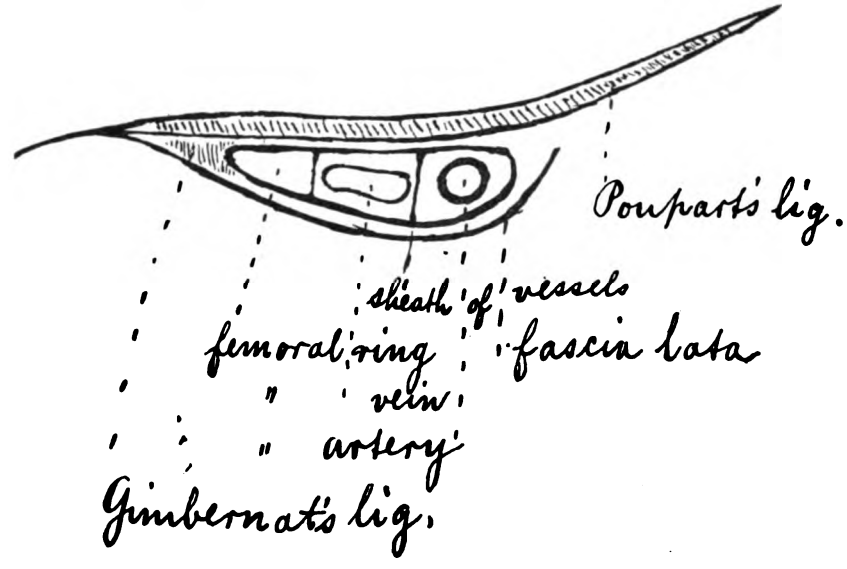
Represents a femoral hernia, the entire sac having been dissected free to a point within the femoral ring, then transfixed and ligated, the sac being drawn out of the wound with forceps, the scissors being in position to cut away the sac beyond the ligature.

If the cavity formed by the removal of the sac contains masses of fat, these should be removed. This may be accomplished in a moment by grasping these masses with a piece of moist gauze. The fat seems to cling to the rough gauze, while the other structures slip through one's grasp. A perfectly clean dissection can be made in this way in a few minutes without harm to blood-vessels and nerves, which would require a considerable time if made with dissecting forceps and scalpel.

This virtually completes the operation with the exception of a row of superficial sutures closing the skin.

If one observes the anatomical relations present, as shown in the accompanying diagram, it is plain that any attempt at closing the femoral canal after the hernial sac has been removed, must to some extent favor the production of a recurrence, because this canal is almost a perfect ring in most cases.

It is a well-known fact that it is practically impossible to keep any ring in the human body open unless it is lined with mucous membrane, or includes a serous membrane containing fluid; consequently the most certain method of closing this ring consists in removing the serous membrane by removing the hernial sac to a point within the abdominal cavity and permitting the ring to close spontaneously. After applying this plan to a large number of femoral herniæ we are convinced that it is quite as impossible to keep this ring open, unless it is distorted by one of the many methods which have been



devised for its closure, as it is to keep any other ring or canal, not lined with serous or mucous membrane, open. In other words, all of the methods which have been devised for closing this ring are more or less harmful and tend to cause a certain number of recurrences. Of course, if the ring has been injured during the reduction of a strangulated hernia, which could not be accomplished without cutting the ring, then this injury must be repaired in order to restore the original favorable conditions.

In case of femoral hernia due to a severe traumatism, especially a violent blow upon this portion of the body, Poupart's ligament is occasionally separated for some distance from its attachment and then the femoral opening may not be a perfect ring, but a broad gap. In such event it is occasionally wise to freshen the edges of this irregular opening and to construct, as nearly as possible, a perfect ring. There is, however, only a very small proportion of cases in which this is necessary. Indeed, it seems as though the tissues forming the femoral ring were increased in amount to quite a marked extent by the irritation due to the presence of the hernia, and when once deprived of its serous lining by the removal of the hernial sac this ring contracts and closes with astonishing rapidity.

In most all these patients it is best, if possible, to institute systematic treatment for a month or two before performing the operation, with a view to reducing the obesity.

After-treatment. It is important to prevent for a short time the protrusion of the peritoneum into the femoral ring in order to secure for this part the best possible conditions for contracting and closing permanently. This may be favored in two ways: first, by reducing the intra-abdominal pressure, and, second, by keeping the contents of the abdominal cavity from approaching the seat of the operation.

Abnormal intra-abdominal pressure may be continuous as a result of the accumulation of gas in the alimentary canal, or as a result of obesity; or it may be intermittent, as in vomiting or coughing, or if the patient suffers from constipation and has to employ an abnormal amount of intra-abdominal pressure during the evacuation of the bowels. Very rarely there is a form of continuous intra-abdominal pressure affecting herniæ in case of ascites.

The intestines and the omentum may be kept away from the region of operation by elevating the foot of the bed six or eight inches during the first week following the operation, at the end of which time the femoral ring will have contracted sufficiently to prevent any protrusion. This posture, however, is not safe for patients who are advanced in age, because in them it is likely to cause a hypostatic congestion of the lungs, which may result in pneumonia.

The abdominal pressure due to constipation can, of course, be readily relieved, not only for the time immediately following the operation, but the patient should understand the importance of remaining perfectly free from this source of trouble. This will also in a great measure remove another important cause of abnormal intra-abdominal pressure, that due to gaseous distension of the stomach and intestines. This may be overcome readily for the time immediately following the operation by having the alimentary canal thoroughly evacuated on the day before by the free use of a cathartic, preferably by the administration of two ounces of castor oil in the foam of beer or malt, the use of enemata and the prohibition of any form of food which is likely to produce gas.

During the first and second days after operation the patient is given hot water flavored with a little beef extract, if desired, then some prepared, predigested food is given every three hours for a few days, then milk and lime water, then soup, and after ten days or two weeks a light diet is allowed.

Aside from the immediate benefit to the patient there is the further advantage in this plan of feeding that the digestive organs are given an opportunity to rest and recuperate from the results of their abuse, which has usually been long-continued and vigorous.

UMBILICAL HERNIA

Example. The patient is forty-nine years of age, a housewife, whose history was of no medical importance until nineteen years ago. At that time, during an attack of whooping cough, she noticed a slight bulging in the region of the umbilicus. Six months later during the birth of her fourth and last child this condition became considerably worse. It continued to develop slowly until ten years ago, when it was suddenly increased on account of a fall. Patient has suffered from mild melancholia for three years.

Patient is obese; pulse and temperature, heart, lungs and kidneys normal; bowels constipated, tongue coated. Abdominal walls very thick. A protrusion is noticed at the umbilicus, the size of a small fist, covered with very thin skin. The mass cannot be reduced into the peritoneal cavity and is very tender upon pressure. There is also tenderness upon pressure in the right inguinal region.

The condition present in this patient can give rise to but one diagnosis—umbilical hernia.

Etiology. This hernia was brought about in the usual manner and under the usual conditions. The abdominal wall had suffered from the effects of

three pregnancies; it had been weakened by an abnormal amount of fat; then it was taxed beyond its strength by the increased intra-abdominal pressure caused by the whooping cough. To this was added another pregnancy and later a fall. Each of these factors favored the further weakening of the abdominal wall and the increase of the hernial protrusion.

Influence of age. In childhood a hernia in this position will heal spontaneously in almost every case, provided the increased intra-abdominal pressure is eliminated, because the opening is a perfect ring composed of tissue which has the tendency to contract. It is quite different in patients over thirty years of age. The increasing obesity primarily overcomes the tendency of the tissues forming the ring to contract; moreover, the abdomen broadens, while the distance between the sternum and the pubis decreases; hence the ring is distorted, which again interferes with its closure.

Still again, the omentum which has been forced into the hernial sac forms inflammatory adhesions and this permanently prevents the closing of the ring.

Remedial measures. Were the hernia reducible there might be a choice between palliative measures consisting in the fitting of a truss, and radical measures consisting in an operation for permanent cure. We have consequently the choice between giving this patient an abdominal bandage with a pouch-like arrangement in which to carry her hernia, and performing an operation.

Indications for operation. The patient is virtually disabled for performing her household duties, because there is a constant dragging feeling in the region of the umbilicus due to the adhesion of the omentum. For the same reason she is unable to walk, and as a result of this she is compelled to lead a sedentary life, which causes her obesity to increase. There is a kind of vicious circle established. The increase in the hernia prevents her from exercising sufficiently to reduce her obesity and this in turn favors the increase in the hernia. Unless she is relieved of her hernia she will become more and more helpless.

Preparatory treatment. The patient has come to the city from a distance and is compelled, on account of her financial circumstances, to return home as soon as possible. It is also impossible for her to return home and come to the hospital later for the operation. Were it not for these circumstances, it would be much better to first place her under treatment for the reduction of her obesity. The same plan would be followed which has already been described in connection with femoral hernia. This being out of question, we have reduced the intra-abdominal pressure as much as possible by the use of saline cathartics, and placing the patient upon a diet of beef-tea for a few days, also giving hot baths followed by cold showers and massage.

The Mayo technique. Of all herniæ this form has been most difficult to treat surgically and has given a larger percentage of recurrences than any other. This has, however, changed since the introduction of Mayo's operation some twelve years ago, which has made the results in this form of herniotomy quite as satisfactory as in the inguinal variety.

The operation comprises the following steps:

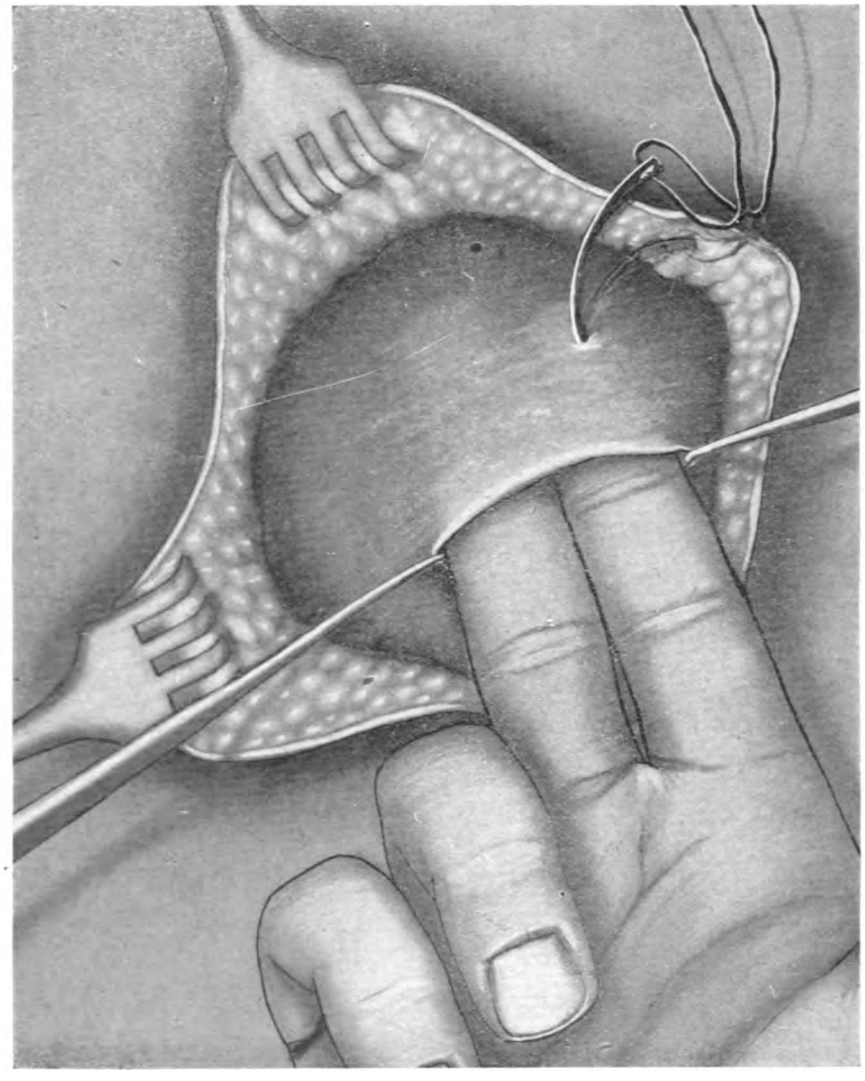
(1) Transverse elliptical incisions are made surrounding the umbilicus and hernia; deepened to the base of the hernial protrusion.

(2) The surfaces of the aponeurotic structures are carefully cleared an inch and a half in all directions from the neck of the sac.

(3) The fibrous and peritoneal coverings of the hernia are divided in a circular manner at the neck, exposing its contents. If intestinal viscera are present the adhesions are separated and restitution made. The contained omentum is ligated and removed with the entire sac of the hernia.

(4) With forceps the margins of the ring are grasped and approximated

Whichever way the overlapping is more easy of accomplishment, suggests the direction of the closure. The illustrations show the overlapping as done from above downward.

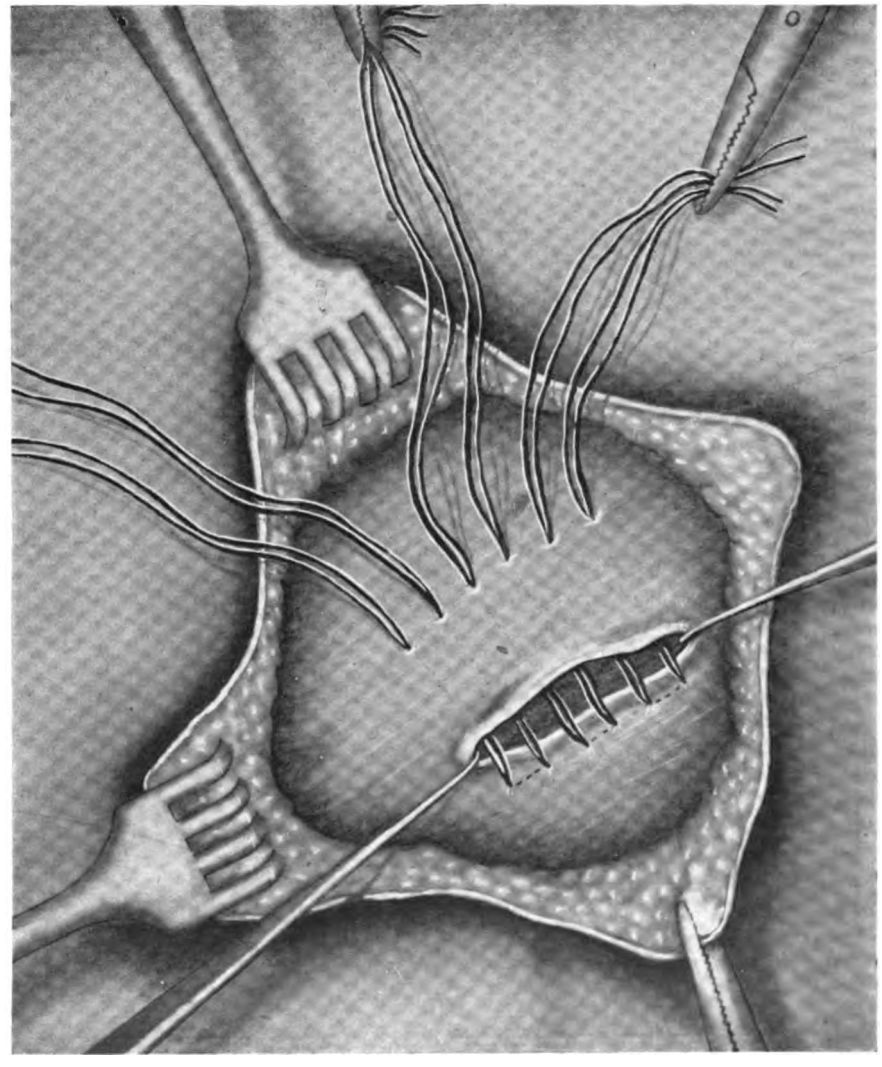


UMBILICAL HERNIA.

Represents the hernial ring in an umbilical hernia laid bare, with the tissues dissected back down to the aponeurosis. Two fingers of one hand are inserted into the abdominal cavity in order to protect the intra-abdominal organs against injury from the needle, which is inserted one and one-half to two inches from the edge of the ring. A blunt hook is inserted on either side to stretch the ring transversely.

(5) For this approximation an incision is made through the aponeurotic and peritoneal structures of the ring extending one inch or more transversely to each side, and the peritoneum is separated from the under surface of the upper of the two flaps thus formed.

(6) Beginning from one to one and one-half inches above the margin of the upper flap, three to four chromicized catgut mattress sutures are introduced, the loop firmly grasping the upper margin of the lower flap; sufficient traction is made on these sutures to enable peritoneal approximation with



UMBILICAL HERNIA.

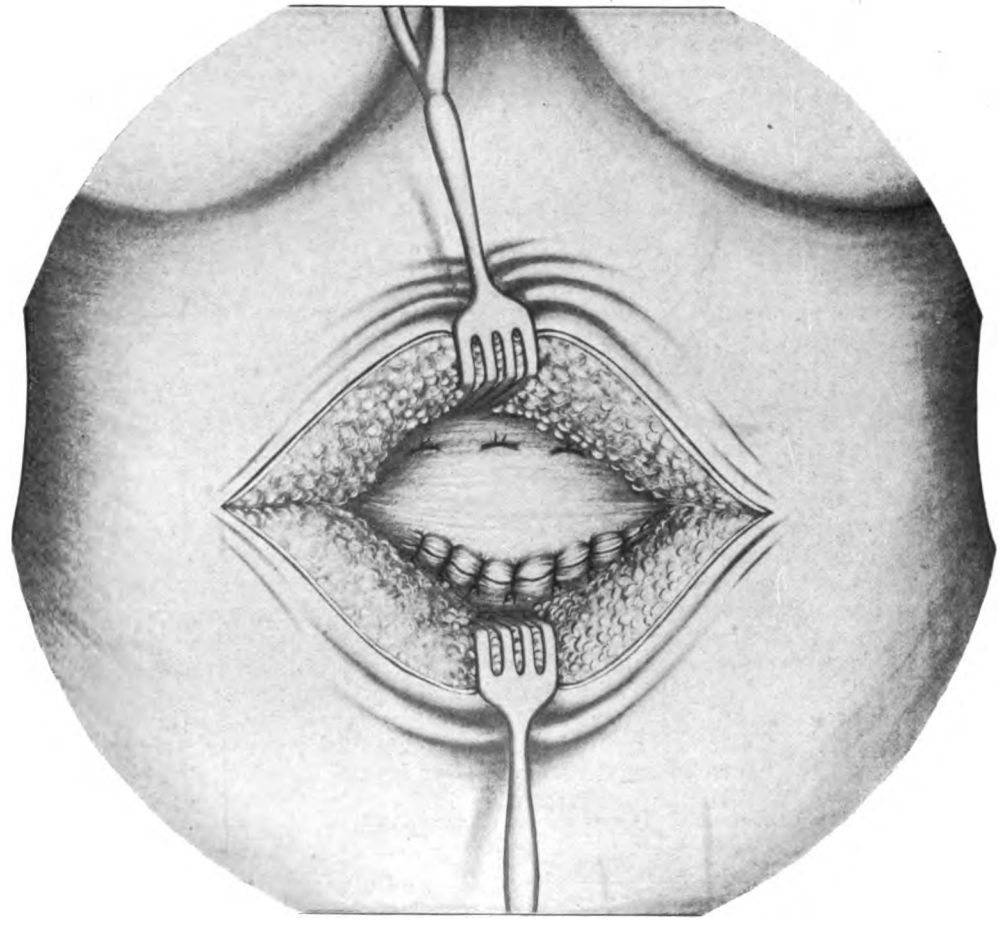
Represents three chromicized cat-gut stitches in position. The cat-gut is represented double. This is not important, but has the advantage of extra security in case there should be a defect in one strand, besides making it possible to use a smaller size of cat-gut.

running sutures of catgut. The mattress sutures are then drawn into position, sliding the entire lower flap into the pocket previously formed between the aponeurosis and the peritoneum above.

(7) The free margin of the upper flap is fixed by catgut sutures to the surface of the aponeurosis below, and the superficial incision closed in the

usual manner. The lateral approximation is carried out by sliding one side under the other in the same manner. In the larger herniæ the incision through the fibrous covering of the sac may be made somewhat above the base, thereby increasing the amount of tissue to be used in the overlapping process.

We have employed chromicized catgut sutures in place of the silver wire sutures in all cases operated by Mayo's method. Having been called upon frequently to remove silver wire sutures which other surgeons had employed



MAYO'S OPERATION FOR UMBILICAL HERNIA.

in various operations, we have abandoned their use entirely and found that chromicized catgut has all of the good qualities, and none of the bad ones of silver wire.

The plate shows the manner in which the stitches are introduced, the fingers protecting the intra-abdominal structures against injury from the needle.

Another plate shows the deep stitches in place, which when tied will slide one edge of the ring underneath the other. The line of sutures should extend transversely across the body instead of obliquely, as pictured by the artist.

In all of our cases we have found it possible to close the opening without tension by placing the line of sutures in this direction.

In small herniæ three deep, and about five superficial, sutures will suffice, but the number may be increased according to the size of the opening.

The next plate shows the manner in which the overlapping edge of the hernial opening is sutured to the aponeurosis.

By this method we obtain a double layer of the strong aponeurosis composed of the fascia of the external and internal oblique abdominal muscles, together with the transversalis fascia.

In all of these patients we have observed the fact that they have a sense of security and strength after this operation which none formerly had after operations for the relief of large umbilical hernia by other methods.

Important points. Having dissected out the entire hernial sac, together with its overlying thin skin down to the edge of the aponeurosis forming the hernial ring, we must plan to open the sac and dispose of its contents.

There are two areas in which the omentum is usually adherent to the sac, one opposite the most superficial portion, the other along the edge of the hernial ring.

If we attempt to open the sac opposite either of these points we will find an exceedingly tedious and unsatisfactory task. It is quite different if we open the sac on one side half-way between these two points, where the surfaces are usually free from adhesions. It is then best to begin at one point and systematically loosen the adhesions between the omentum and the hernial ring until the former is entirely free. If this is done the entire task can be accomplished in a few minutes, but if one loosens small areas here and there in an unsystematic manner, a great amount of time may be unnecessarily consumed to the detriment of the patient.

Should the sac contain intestines still greater care must be employed for fear of causing a perforation. Should there be an abrasion on the surface of the intestine this should be covered at once with a few Lembert sutures.

Having loosened all of the adhesions between the omentum and the hernial ring, it becomes necessary to dispose of the mass of omentum. The latter is usually so matted together that it would undoubtedly give rise to great discomfort from pressure were it to be returned to the abdominal cavity; it is consequently best to ligate it in a number of portions, to cut away the part that has been matted together, and return the remaining portion into the abdominal cavity. At this point it is important to observe care not to place the ligatures too near the transverse colon for fear of causing necrosis.

Prognosis. If this plan of treatment is followed the prognosis in these cases is astonishingly good, both as regards immediate and permanent results.

After-treatment. It is well to avoid all abnormal intra-abdominal pressure (1) by reducing the obesity by means of diet and vigorous exercise, preferably walking; (2) by avoiding constipation; (3) by regulating the diet so as to avoid gaseous distension; (4) in the male by avoiding obstruction of the urethra, or correcting this should it exist.

Variation of incision. Occasionally one will find a small umbilical hernia in a patient to be operated for some other intra-abdominal condition, like tumors of the pelvic organs, appendicitis or gall-stones.

If the incision in this operation is to be in the median line it is best to extend it above the umbilicus a distance of one or two inches, to excise the umbilicus entirely, to split the fascia of the recti muscles toward the median line and then to close the abdominal wound throughout as though there had been no hernia.

If the operation is for the removal of the appendix or gall-stones it is well to make the incision through the right rectus abdominis muscles, then the inner edge of the abdominal wall can be everted. If there is adherent omentum in the hernial sac this can be peeled out and then a purse-string suture of chromicized catgut passed around the hernial ring with a short curved needle just outside of the abdominal wall and tied just tightly enough to hold the edges in apposition. A second similar stitch is applied just within the abdominal wall and tied in the same manner.

This may be done very easily except in patients with an usually thick abdominal wall. The method is, however, applicable only to herniæ of moderate size.

VENTRAL HERNIA FOLLOWING ABDOMINAL SURGERY

Type of case. The patient, an unmarried woman twenty-two years of age, an office girl by occupation, gives the following history: Uneventful life until age of eighteen, when she had an acute attack of appendicitis, which subsided under treatment but recurred every few months. Two years ago she had an operation for the relief of this condition at the end of an acute attack. The wound suppurated and healed in time by granulation. The patient has been free from acute pain since that time, but has suffered from severe gaseous distension of the abdomen, from digestive disturbances and from constipation. The scar began to broaden soon after the patient returned to her work and shortly afterwards she noticed a distinct bulging of the abdominal wall at the point of the scar. This portion of the abdominal wall has become constantly thinner and the bulging has increased.

There is a scar ten centimeters in length and five centimeters wide, extending parallel with Poupart's ligament about half-way between the anterior superior spine of the ilium and the umbilicus. The tissue is so thin that the motion of the intestines can readily be distinguished through it. Upon pressing the fingers against this tissue one may readily feel a definite ledge composed of the abdominal muscles on either side, and the intestines can be readily felt behind this thin structure. There is a strong impulse upon coughing. The scar is very tender upon pressure.

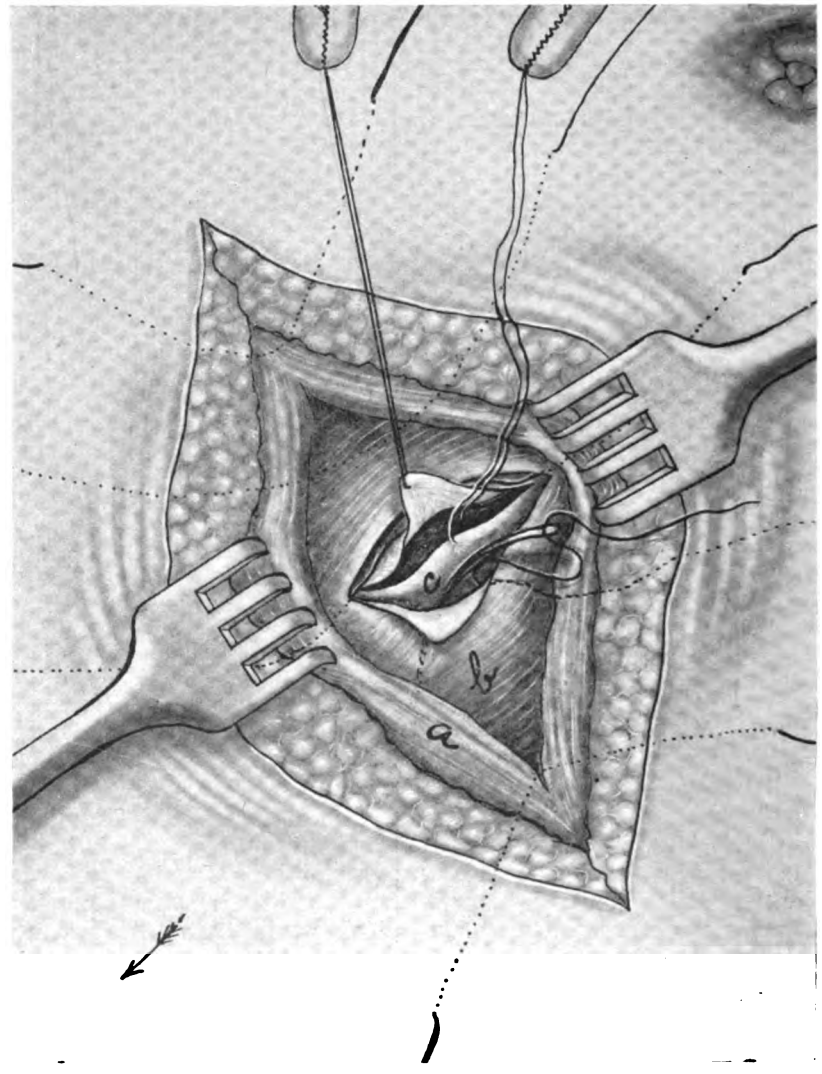
Etiology. In this instance there had been an abdominal section for the removal of the appendix. The incision had been made parallel with the fibers of the external oblique abdominal muscle, then it had been carried through the internal oblique, the transversalis fascia and peritoneum.

All of these layers had been united after the operation, but the suppuration which followed prevented primary union and consequently there was a union between the edges of all the layers involved on each side of the line of incision and the edges thus formed were united by a mass of cicatricial tissue. This is the least stable of all tissues and consequently it began to stretch very soon after the patient left her bed, becoming more and more thinned out from day to day and permitting the intra-abdominal organs to protrude, forming a ventral hernia.

There is another factor in this case which favored the formation of a ventral hernia. The incision was parallel with the fibers of the external oblique abdominal muscle and consequently none of the fibers of this muscle had to be severed, as they were simply split longitudinally. Had the internal oblique abdominal muscle been likewise split, as shown in plate, the two edges would have been drawn closely together as a result of their own contraction, and the lines of incision through the two muscular layers, being at right angles to each other, a hernia would not have developed, even though the wound had not united primarily.

In this case the conditions were quite different, the fibers of the internal oblique abdominal muscle being cut at right angles, the edges of the wound were drawn farther and farther apart with each contraction of this muscle

as soon as primary union of the cut ends became impossible on account of suppuration. Moreover, these ends became adherent to the edges of the wound in the external oblique abdominal muscle and overcame the tendency these edges naturally show to remain parallel and in close apposition.

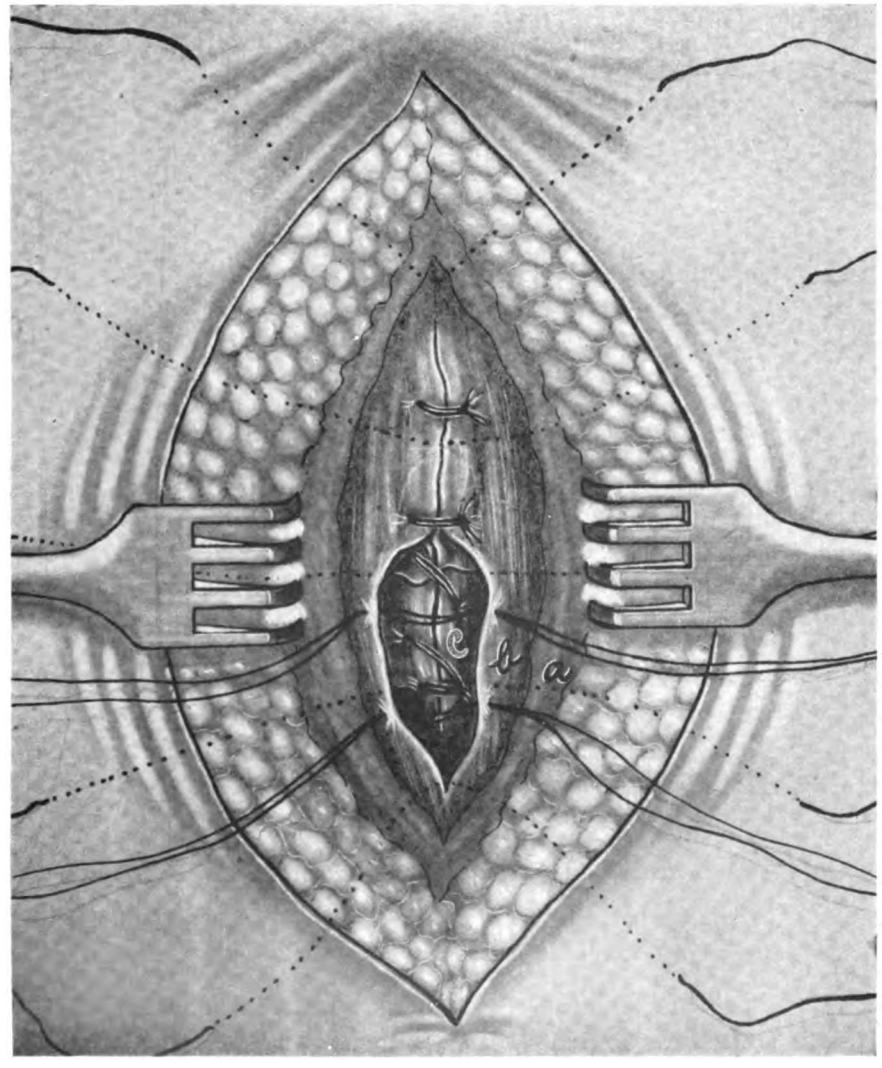


McBURNEY'S INCISION.

Represents McBurney's incision, which extends parallel with the fibres of the external oblique abdominal muscle, (a) separating its fibres without cutting them, then separating the fibres of the internal oblique muscle, (b) again without cutting its fibres and extending through the transversalis fascia and peritoneum (c) in the same direction.

Indications for operation. In most cases of ventral hernia following abdominal section there is no definite ring, the opening being wide; there is consequently no danger from strangulation. There is, however, the constant feeling of insecurity and weakness in the abdominal wall which prevents the

patient from performing the duties, or indulging in the pastimes, of persons in health, and as the tissues become thinner and thinner, there is really some risk of having them give way entirely.



CLOSURE OF ABDOMINAL WOUND.

Represents the manner of applying sutures in closing an abdominal incision in the median line; (a) representing the deep strong fascia composed of the aponeurosis of the external oblique abdominal muscles; (b) the rectus abdominis muscle, and (c) the transversalis fascia and peritoneum.

Moreover, the digestive disturbances of which such patients complain are due partly to the fact that there are usually adhesions between the intestines and omentum and the scar which interfere with the passage of food and gases through the portion of the alimentary canal thus impaired.

When the protrusion is so great as above described, and cannot be com-

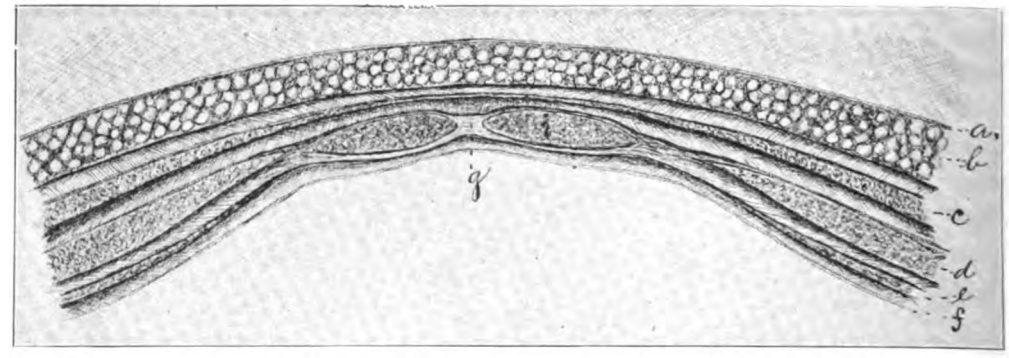
fortably retained by means of a bandage, there is a sufficient amount of mechanical obstruction to the intestines from their crowding into this pouch to account for the digestive disturbances. For these reasons it seems wise to advise operative treatment, especially in young patients.

Operative technique. We first make an incision surrounding all of the scar tissue, because this is of no value in securing a permanent cure of the hernia and its removal is of importance from a cosmetic standpoint.

In these herniæ, as in umbilical, the adhesions of omentum or intestine are likely to be to the most prominent portion of the hernial protrusion or to the edge of the hernial ring, which in these cases is so large as scarcely to deserve this name, or to both of these portions.

The operation is greatly facilitated by making the incision through the peritoneum at a point where there are no adhesions. This may usually be accomplished by choosing a location half-way between the two points just mentioned.

A further aid is found in lifting up the tissues with two dissecting forceps,



ABDOMINAL WALL, UPPER THREE-FOURTHS.

a skin; *b* fat; *c* external oblique abdominal muscle; *d* internal oblique abdominal muscle; *e* transversalis fascia; *f* peritoneum; *g* linea alba; *i* rectus abdominis muscle. The aponeurosis is divided into an external and an internal layer, the former passing in front, the latter behind the rectus abdominis muscle.

one in the hand of an assistant, the other in the surgeon's hand, and cutting between.

As soon as the peritoneal cavity has been opened, all adhesions are carefully separated in a systematic manner. If abrasion occurs upon the serous surface of an intestine this is at once covered with one or more Lembert stitches. Should the omentum be matted together or appear in irregular bunches or strands these are ligated and cut away. Then the intestines and omentum are replaced into the abdominal cavity and covered with a broad pad of sterilized gauze, moistened with warm normal salt solution.

It now becomes necessary to make a careful dissection of the edges of the wound, in order to lay bare each one of the layers of tissue. This is possible even in cases in which the hernia has existed for a number of years.

We first come to the edges of the incision in the external oblique abdominal muscle and its fascia, then we encounter the fibers of the internal oblique, cut at right angles and greatly retracted, and lastly upon the transversalis fascia and peritoneum combined. We have found that a hernia in which all the layers have been carefully dissected out in this manner may be closed with the same degree of certainty, as regards permanency of cure, as an ordinary laparotomy wound.

A row of silkworm gut sutures is now inserted, but not tied. The stitches are placed about three-fourths of an inch apart and grasp each layer down to, but not through, the peritoneum. In this case we take especial care to draw the internal oblique abdominal muscle forward with dissecting forceps in order to secure a deep bite. Each layer is then sutured separately with a continuous catgut stitch. For this purpose we prefer to utilize fine chromicized catgut, No. 1, threaded double. This gives the suture the same strength as a heavier catgut used single and has the advantage that it does not twist nor become unthreaded, and, theoretically at least, it offers more favorable conditions for absorption when it has accomplished its purpose.

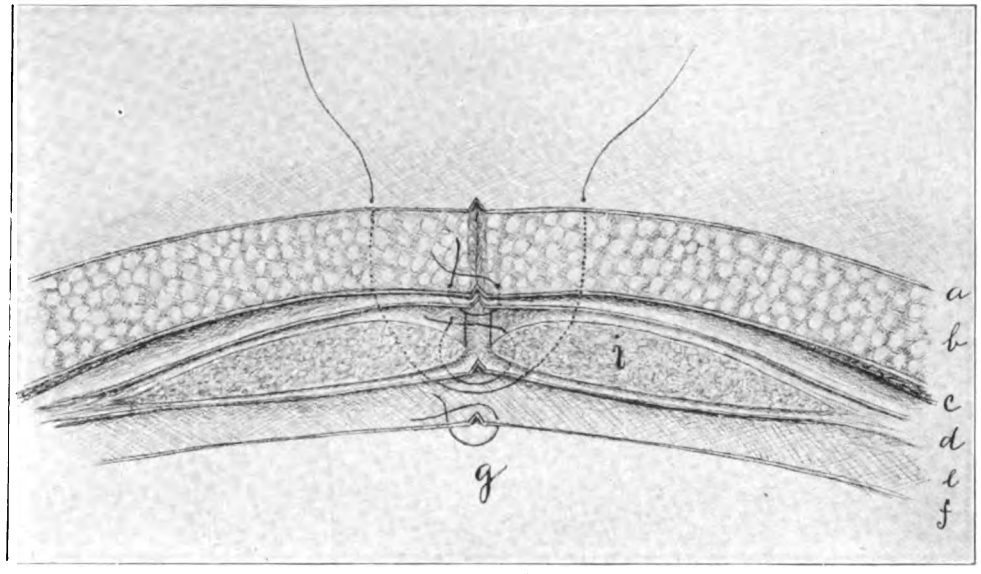


DIAGRAM SHOWING ABDOMINAL SECTION IN MEDIAN LINE IN UPPER THREE-FOURTHS OF ABDOMINAL WALL.

a skin; *b* fat; *c* aponeurosis of external oblique abdominal muscle; *d* aponeurosis of internal oblique abdominal muscle, divided, the upper half passing with the aponeurosis of the external oblique in front of the rectus abdominis muscle (*i*) the lower half joining the transversalis fascia and passing behind the rectus abdominis muscle; *e* transversalis fascia; *f* peritoneum; *g* line of incision. The lower layer of the aponeurosis of the internal oblique abdominis muscle; the transversalis fascia and the peritoneum are usually very closely united, although they can usually be easily separated in the absence of inflammatory processes.

After each layer has been sutured carefully, the silkworm gut sutures are tied over all. We believe that it is most important never to draw any of these stitches too tightly for fear of causing pressure-necrosis.

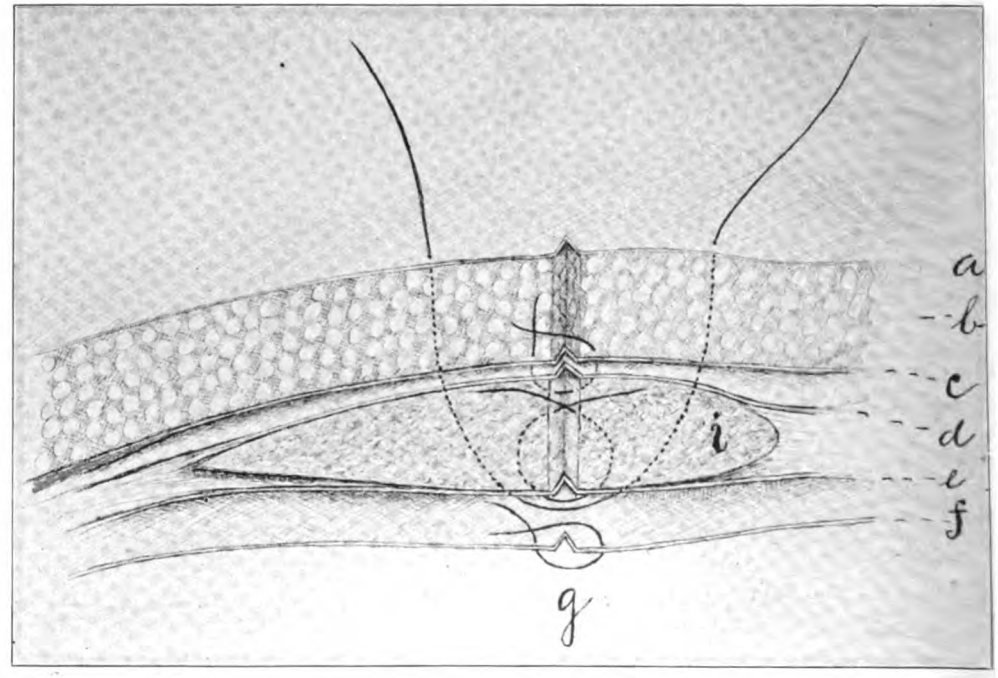
A narrow pad of sterile gauze is laid upon the wound and then the abdominal wall is supported with two straps of rubber adhesive plaster, at least two inches wide, in order to relieve the tension upon the sutures.

Principles of cure. It does not matter in what portion of the abdominal wall the ventral hernia following an abdominal section may occur, the principles concerned in its closure are always the same. The cicatricial tissue is carefully excised, the different anatomical layers are dissected out and then united with deep silkworm gut sutures, while each layer is united separately with buried sutures of chromicized catgut which may be applied in continued or interrupted form.

As most of these herniæ occur either after appendicitis operations in the right inguinal region, or in the median line between the umbilicus and the pubis, we also illustrate the operation in the latter variety.

In this position our dissection must expose the deep fascia composed of the aponeurosis of the external and internal oblique abdominal muscles, the rectus abdominis muscle on either side and the transversalis fascia and peritoneum which are closely united.

In the plate these layers are shown, the silkworm gut stitches being in place but not tied. The peritoneum and transversalis fascia have been united by means of a continuous catgut suture passing over the silkworm gut sutures



ABDOMINAL WALL IN LOWER ONE-FOURTH OF DISTANCE BETWEEN STERNUM AND PUBIS.

Showing the entire aponeurosis of the internal oblique abdominal muscle extending in front of the rectus abdominis muscle (*d*) together with the aponeurosis of the external oblique (*c*). All sutures are in place, the silkworm gut suture extending through all layers down to, but not through, the peritoneum (*f*) the rectus muscle (*i*) and the aponeurosis of the internal (*d*) external (*c*) oblique, each being sutured separately with catgut.

so that the latter when tied will bring up the peritoneum and thus prevent the formation of dead spaces between this and the posterior surface of the recti-muscles.

The interrupted stitches have been passed through the recti muscles in the upper part of the wound and tied and two others have been inserted in the lower part of the wound and left untied in order to show the deeper stitches.

The deep fascia, composed of the aponeurosis of the internal and external oblique abdominal muscle, which is the most important layer, will be carefully sutured over this, as shown, and then the deep silkworm gut sutures will be tied and a row of superficial sutures applied for coaptation of the skin.

A similar dressing will be applied as described above and the abdominal walls will be supported with rubber adhesive plaster as before.

HERNIA OF THE LINEA ALBA

Typical case. A gardener by occupation, forty-six years of age, gives the following history: He has always been in good health, with the exception of having had an attack of mountain fever lasting ten weeks, from which he suffered many years ago.

He does not remember having suffered any injury, but he has had a number of periods of intoxication lasting for several days at a time, during which he might easily have sustained some injury without knowing it. Six years ago he noticed a small swelling in the median line half-way between the end of the sternum and the umbilicus. This has increased steadily until it has attained the size of a hen's egg. Usually he has had simply a feeling of weight in this swelling, but occasionally it is quite painful for several days. There is a slight decrease in the size of the swelling at night and a slight increase when working hard.

Patient is well nourished, thoracic and abdominal organs normal, appetite good, bowels constipated. Two inches above the umbilicus, in the median line, there is a swelling as large as a hen's egg, not painful on pressure, semi-fluctuating, no impulse upon coughing, not reducible upon pressure. In all other respects the physical examination has resulted negatively.

Judging from the consistency of the tumor, from its oval, slightly lobulated form, and its subcutaneous location, it is likely that it is composed of fatty tissue. It may consequently be a lipoma. Were there a history of traumatism immediately preceding its appearance, or were there an impulse upon coughing, we could make a positive diagnosis of a hernia of the linea alba.

Differential diagnosis. There are certain peculiarities in this case which point distinctly to the latter diagnosis:

(1) There has been a disturbance of the stomach since the appearance of the swelling, which is due in many cases of hernia of the linea alba to the fact that the adherent omentum interferes with the normal motility of the stomach. The opening in the linea alba is frequently so small that an impulse upon coughing is not possible. This is still further interfered with by the extensive adhesions of the omentum to the hernial sac, which is frequently not a true sac composed of peritoneum and transversalis fascia, but simply a space in the ruptured tissues. This disturbance is sometimes so great that the patient is entirely disabled.

(2) The tumor varies in size, decreasing a little at night and increasing perceptibly upon making severe exertion for a considerable time, as upon working very hard. Although there is no impulse upon coughing or straining it seems that more of the tissue of the omentum becomes forced through the small hernial opening when there is long-continued abnormal intra-abdominal pressure than when this is normal.

(3) The swelling becomes painful at irregular intervals, especially when the patient engages in hard work. We have repeatedly seen strong, otherwise perfectly healthy men entirely disabled for work by the pain resulting from a hernia in this region, so small that it had escaped the notice of physicians and surgeons for years, the patient not taking it to be of sufficient importance to require their attention.

(4) The swelling usually appears suddenly after an injury, such as a sharp blow upon the linea alba.

Considering all of these facts it seems likely that this is a hernia of the linea alba, although we cannot be absolutely positive in our diagnosis until the mass has been exposed.

Etiology. In this case the etiology is not very clear on account of the fact that it is likely the patient's powers of observation were greatly impaired at the time at which the condition was produced.

Indications for operation. The amount of suffering is not sufficient to disable the patient from performing his work, but he suffers from gastric disturbances and from pain in the region of the swelling whenever he labors

hard, and the periods of acute irritation are becoming more numerous, and the extent of the irritation more severe constantly. Moreover, the swelling is becoming more and more sensitive to pressure from the clothing.

Were it possible to reduce this swelling into the abdominal cavity its retention by means of a truss might be considered, but experience has shown that this would not succeed.

The patient is not in any immediate danger, because the opening is too high in the median line to permit the protrusion of a portion of the small intestine, and it is too small to engage either the stomach or the transverse colon. There is consequently no danger of strangulation.

The patient is familiar with all of these facts and has chosen the operation for the purpose of securing relief from pain and to increase his working capacity.

The preparatory treatment is the same as in all abdominal sections. Were the patient very obese, we would advise treatment for the relief of this encumbrance.

Operative technique. A longitudinal incision twelve centimeters in length is made over the most prominent portion of the swelling, through the skin and superficial fascia, which exposes a flattened, oval mass as large as a hen's egg. Lifting up the edges of this mass the finger reaches a point in the aponeurosis forming the linea alba which is defective. At this point the latter has a perforation which would admit two fingers were it not occupied by a projection of the fatty swelling which we have exposed. The latter is lobulated, quite vascular and is slightly adherent to the surrounding tissues. It is not surrounded by a true hernial sac. It has consequently come through in the defect in the abdominal wall and we have before us a hernia of the linea alba, and the fatty mass is composed of omentum which has been forced out of the peritoneal cavity through this opening.

It is impossible to replace the omentum into the peritoneal cavity, and if it were it would not be desirable to do so because it has been so completely changed from a thin, delicate, protecting sheet into a clumsy mass, that it would probably give rise to irritation were it replaced. We will consequently transfix the narrowed portion, at the point where it issues from the opening in the aponeurosis, with a double catgut ligature, tie it in halves, cut away the mass a sufficient distance outside of the ligature to prevent slipping, and drop the stump into the abdominal cavity.

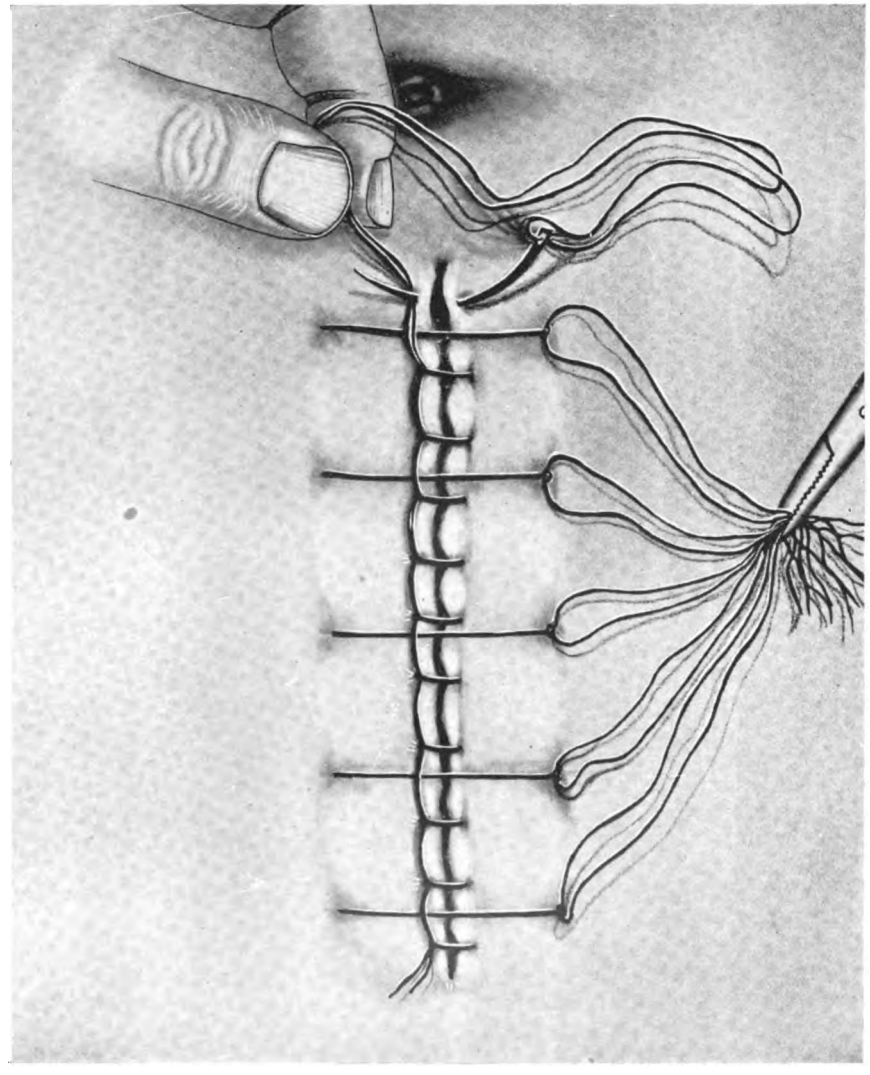
It frequently happens that the fat contained in a hernia of the linea alba is partly or entirely composed of pre-peritoneal fat instead of omentum. These patients suffer even greater pain than those in which the mass is composed entirely of omentum. When this mass is removed the pedicle is simply reduced through the hernial opening into the pre-peritoneal space.

The remaining steps of the operation vary according to the character of the opening. If this is small and circular, and if its edges are thick, it is probably quite as unnecessary to do anything toward closing it as in femoral hernia. As soon as the ring is empty it will close spontaneously.

If the opening is oblong or triangular in form but not more than two or three centimeters in length with substantial edges, these may be brought together with two or three buried, chromicized catgut sutures. If, however, the opening is oblong and its edges thin, as in this case, it is likely there would be a recurrence unless the defect were repaired in a more substantial manner.

In order to secure favorable conditions for a permanent cure in these cases it is necessary to carefully expose each one of the various layers composing the abdominal wall at this point and then to close the wound precisely in the manner described in operations for ventral hernia following abdominal

section in the median line. The anatomical layers in this portion of the linea alba from without inward are as follows: 1, skin; 2, superficial fascia; 3, fat; 4, strong fascia composed of the aponeurosis of the external oblique abdominal muscle and the outer half of the fascia of the internal oblique; 5, rectus



CLOSURE OF ABDOMINAL WOUND.

Represents the deep silkworm gut sutures tied loosely so as to avoid pressure necrosis and a continuous coaptation stitch for the accurate adjustment of the edges of the skin.

abdominis muscle; 6, the inner half of the fascia of the internal oblique abdominal muscle; 7, the transversalis fascia; 8, peritoneum. The last three layers mentioned are usually so closely united with each other that they appear as one.

Having exposed these layers we close the wound as shown heretofore.

A row of silkworm gut sutures extending through all the layers down to

the peritoneum are inserted but not tied. Then the deepest layer composed of peritoneum, transversalis fascia and the inner half of the aponeurosis of the internal oblique abdominal muscle is sutured with a continuous catgut suture. Now the recti muscles are brought together by means of just a sufficient number of interrupted catgut sutures to bring them in accurate apposition. The strong, deep fascia, upon which the permanency of the cure really depends, is next carefully sutured with chromicized catgut; and then the deep silkworm gut sutures are tied and, if necessary, a row of coaptation stitches is applied to adjust the edges of the skin.

In connection with this case we wish to direct attention particularly to the diagnosis of these troubles.

They are somewhat rare and almost never diagnosed until they have suffered for many years. In the meantime they usually go from one physician to another, receiving treatment alternately for the relief of gastric disturbances and neurasthenia.

HERNIA IN CHILDREN

Example. A boy, twenty months of age, comes with the following history: He has always been well and strong since birth and none of his functions has been impaired. There is a vague history of a fall two months ago, but nothing definite can be determined in this respect. It is quite likely that the mother imagines this from the fact that she feels compelled to account for the child's condition in some way.

Six months ago the mother noticed a swelling in the region of the left inguinal canal extending into the scrotum on that side. This swelling decreases in size when the child is in bed, but cannot be reduced while he is awake. The protrusion increases when the child cries. There is an abundance of fat in the subcutaneous tissues and it is difficult to determine whether the mass fluctuates upon palpation. An attempt has been made to apply a truss, but the child screamed incessantly when this was in place, so that it had to be removed directly. The child is otherwise normal, with the exception of having an adherent prepuce.

Differential diagnosis. It is often difficult to make a positive diagnosis in a child so young as this one, because it is practically impossible to keep him quiet long enough to determine the conditions present, unless he is anesthetized.

Hydrocele is the only condition, aside from hernia, which is common in children of this age causing a swelling in this position. In one case we encountered a lymphangioma, and a congenital lipoma, or one developing shortly after birth, which is possible in this location, but so rare that it really need not be considered.

Now that the child is anesthetized, we find that the swelling can be reduced into the abdominal cavity through the inguinal canal, but as soon as the pressure is released it reappears at once. There is also the sensation to touch of reducing a mass of a definite, permanent form which would not be the case were the swelling composed of omentum or intestine contained in a hernial sac. The condition present must consequently be an irreducible hydrocele of the cord.

Etiology. In this patient the communication between the peritoneal cavity and the tunica vaginalis evidently remained open after the descent of the testicle and gave rise to a congenital hernia. At some time later the upper end of this hernial sac closed by adhesion of its walls, and then its serous lining, instead of becoming adherent to the tissues of the spermatic cord and thus bringing about a spontaneous cure, secreted fluid and this caused the distension of this sac. Being located in the inguinal canal the latter cannot close, hence the impulse upon coughing or straining.

Indications for operation. So long as the inguinal canal is distended by this pouch filled with fluid it is impossible for it to close and the development

of the child cannot proceed normally. The mass cannot be reduced into the peritoneal cavity thus leaving the canal free to close, neither can it be withdrawn downward. It is consequently necessary to resort to some operative measure for the relief of the condition. This can be accomplished by withdrawing the fluid by means of a canula, but this would probably not secure permanent relief because the serous fluid would re-form unless some irritating substance was injected which would result in a sufficient amount of aseptic inflammation to cause the surfaces to adhere. For this purpose a few drops of ninety-five per cent. solution of carbolic acid has been injected, or a larger quantity of five per cent. solution of the same substance, or a few drops of tincture of iodine. None of these substances is, however, certain to accomplish the end desired and none of them entirely harmless. We will consequently choose a method which is not connected with more danger and which will result in a permanent cure.

Technique of operation. An incision is made over the most prominent portion of the swelling parallel with the inguinal canal and down to the hernial sac. It is now apparent that the sac is distended with fluid. We incise it and permit the fluid to escape. We find a smooth sac containing nothing but about thirty cubic centimeters of a clear fluid. The sac is easily separated from the surrounding tissues. At its upper end it is found closed by means of scar tissue which has united its walls. It is withdrawn from the inguinal canal a little further, then transfixed with a needle threaded with catgut and tied. Then the sac is cut away, care being taken to leave a sufficient amount of tissue beyond the ligature to prevent slipping. The stump is permitted to retract within the abdominal cavity. No attempt is made to close the inguinal canal, because this occurs spontaneously in children as soon as the sac is removed. Suturing the skin completes the operation.

Carefully compiled statistics have shown that of all the herniæ encountered in the adult less than five per cent. have existed since childhood, and also that of all children under six years of age suffering from hernia seventy-three per cent. will heal spontaneously, without any form of treatment, before the age of thirteen, consequently the relative number of herniæ in children requiring operative treatment must be very small.

Conditions favoring spontaneous cure. Spontaneous cure is accomplished. (1) By the late closure of the inguinal canal, which should have occurred before birth; (2) By the broadening of the pelvis. The parietal peritoneum enlarges at the expense of the mesentery; the latter being thus shortened prevents the entrance of the intestines into the inguinal canal; (3) By the displacement of the internal abdominal ring with the growth of the child; (4) With the growth of the child a number of the predisposing causes are eliminated.

Predisposing conditions to overcome. (a.) *Abnormal intra-abdominal pressure.*—There can be no doubt that the most important direct cause of herniæ in children is an abnormal intra-abdominal pressure. This may be due: 1, To gaseous distension of the stomach and bowels, caused by faulty feeding and consequent indigestion; 2, To great pressure exerted during the act of defecation, on account of constipation; 3, To the same condition due to obstruction on account of phimosis; 4, To severe vomiting; 5, To long-continued coughing. In connection with all of these conditions, it is to be remembered that children with digestive disturbances necessarily suffer much from pain, and the exertion incident to crying will greatly increase the existing abnormal intra-abdominal pressure. In order to quiet the child the mother will nurse it at irregular intervals and this will again increase the digestive disorder, and this, in turn, the intra-abdominal pressure and pain.

(b.) *Increased intra-abdominal pressure due to coughing.*—We have ob-

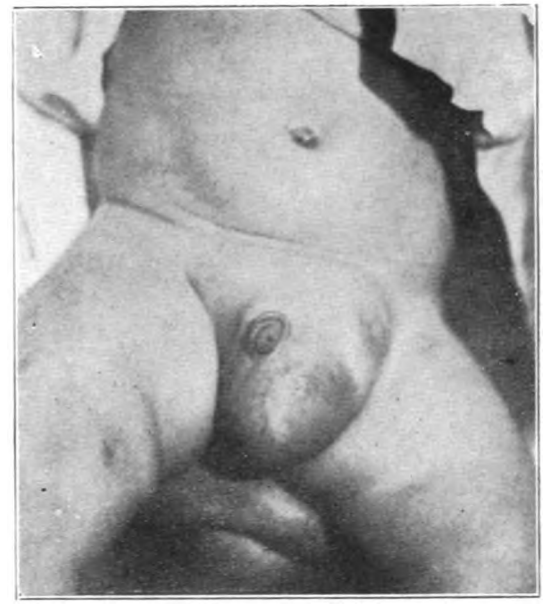
served cases in which the herniæ healed regularly during the summer months, but reappeared in the autumn as soon as the children acquired coughs, which lasted almost all winter. By the time spring arrived the herniæ had attained considerable size, only to heal again during the summer while the patients were free from coughs. By placing these children in bed and elevating the lower end sufficiently to make an angle of twenty degrees and giving them remedies to relieve the cough, the herniæ disappeared within six weeks. Then advising the mothers to give the children cold baths every day and to bring them for inspection often enough to keep the condition under control, and giving them codliver oil and malt extract as soon as the cold weather appeared, they went through the next winter without coughs and consequently without a recurrence of the herniæ. In the same manner children who are suffering from obstruction to the upper air-passages, on account of enlarged tonsils, nasal adenoids or polypi and consequent conditions, will rapidly recover from their herniæ if these conditions are relieved by proper treatment.

(c.) *Increased pressure due to gaseous distension.*—It is very usual for the children who are brought into the hospitals for the treatment of hernia to have greatly distended abdomens due to digestive disorders resulting in gaseous distension of the stomach and intestines. If this occurs in nursing infants the mother should be instructed to nurse the child at regular times. Her own habits and diet should also be regulated. If the child is constipated this condition should be relieved. Aside from this the mother must be instructed never to carry the child, because she will not follow the advice of keeping it in the inverted position, and, consequently, will increase the intra-abdominal pressure whenever she picks up the infant. It should sleep in a separate bed with the lower end elevated sufficiently to make an angle with the floor of about twenty or thirty degrees. This will keep the hernial sac empty of intestines and omentum and will very greatly assist in the obliteration of the hernia. If the mother's milk continues to give rise to indigestion, notwithstanding every precaution available for making it wholesome, it is often best to place the child partly or wholly on artificial food, at least for a time. Above all things, however, it is important to impress the mother with the necessity of being regular in feeding the child and to again place it in its bed as soon as it has been nourished, or, better still, to lean over the child's bed and nurse it without disturbing its partly inverted position.

We have repeatedly placed these children in the hospital and sent the mother, who was exhausted from overwork and care of the sick child, home to rest, permitting her to come to the hospital morning, noon and night to nurse the child. After the first day or two the mother becomes rested, her journey to and from the hospital compel her to be out of doors, and the fact that she is relieved of the care of the child gives her the necessary rest and sleep. In the meantime her milk improves, the child becomes accustomed to lie quietly in bed and to take its nourishment regularly, its digestion improves, the gaseous distension disappears, and with it the abnormal intra-abdominal pressure, which is still further relieved because the child sleeps most of the time and seldom cries. After the child has been in the partly inverted position for a few days the hernial sac remains empty so long as this position is continued, even if he strains and cries.

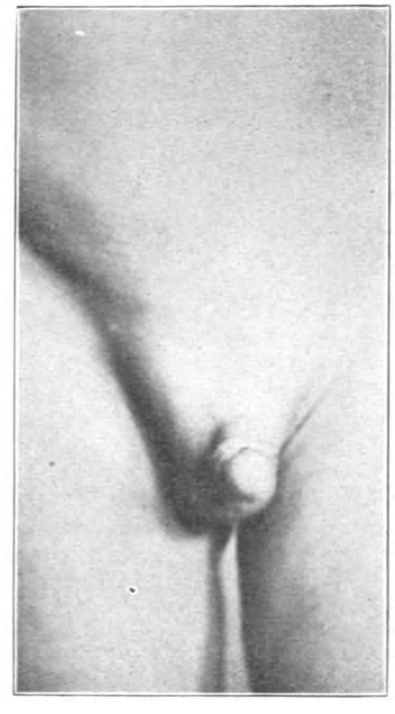
(d.) *Increased intra-abdominal pressure during defecation, due to constipation.*—Children suffering from hernia should not be allowed to become constipated, because the increased intra-abdominal pressure necessary to accomplish the evacuation of the bowels in constipation is in itself sufficient to prevent a hernial aperture from closing. This is one of the most common causes of hernia in children, and one of the easiest to be eliminated.

(e.) *Increased intra-abdominal pressure due to obstruction to the passage*



CONGENITAL OBLIQUE INGUINAL HERNIA IN A CHILD OF ELEVEN MONTHS.

Strangulation Irreducible. Treatment—Herniotomy. Loop of Ileum Twisted at the Hernial Ring. Color of Bowel Coppery-Red. Bowel Irreducible Until the Hernial Ring Was Incised. Closure by Imbrication.



CONGENITAL OBLIQUE INGUINAL HERNIA AND HYDROCELE OF THE CORD IN A BOY 4¼ YEARS OF AGE. TREATMENT—HERNIOTOMY AND OBLITERATION OF BOTH SACS.

of urine as a result of phimosis.—That phimosis is a frequent cause of hernia in children is plain from the fact of the greater frequency of umbilical hernia in male than in female children. The greater frequency of inguinal hernia in male children can readily be accounted for by the difference in the anatomic structures, but this is not the case in umbilical herniæ, which is also shown statistically to be more common in male than in female children. It has lately been suggested that phimosis cannot be an important cause of hernia in children, because if this were the case the Jewish nation must necessarily be much freer from hernia than others. This is, however, not the case. In fact, it has been shown by statistics, especially in Russia, that at the age of twenty to twenty-one proportionally more Jews than Christians are afflicted with hernia. This, however, may be explained by the fact that the Jews are more subject to hereditary diseases of all kinds, on account of the system of intermarriage in families.

If the phimosis is relieved, either by circumcision or by dilatation of the prepuce, and the child kept in bed for four to six weeks with the foot of the bed elevated, the hernia will almost invariably be cured. During the same time the diet and the bowels must be carefully regulated, and it is doubtful which of these three means has been of the greatest importance in producing a cure. It is surprising how rapidly the opening will contract under these conditions. Moreover, during this time the patient acquires regular habits which may afterwards be easily maintained if their importance is explained to the mother, and especially if it is impressed on her that by following the directions, which will naturally appeal to her on account of their simplicity and reasonableness, she will be able to make operative treatment unnecessary.

That all of these conditions are of the greatest importance may be demonstrated practically, with the greatest ease, by comparing the relative frequency of hernia in children of the very ignorant poor, of the intelligent poor, and of the well-to-do. In the former class, after the child is weaned, but little attention is given to its diet, to the state of its bowels, and to the condition of the prepuce in boys, and consequently herniæ are very common, while they are much less common in the second, and still less in the third class.

STRANGULATED HERNIA IN CHILDREN

If a strangulated hernia in a child cannot be easily reduced, under complete anesthesia, by taxis, the child being held in the inverted position during the manipulations, it is undoubtedly wiser to relieve the danger by an operation, because the intestinal wall in children is very delicate and easily injured by taxis. In our experience the hernial opening has always been very narrow; still we have always succeeded in replacing the hernial contents, without enlarging the opening, by first drawing out more intestine and then gradually replacing it, the child being maintained in the inverted position.

Technique. If the hernia is an acquired one, which is not common in children, the sac is carefully dissected free to a point within the abdominal cavity. It is then ligated and removed and the ligated stump permitted to retract into the peritoneal cavity.

If the hernia is congenital it is best to dissect up the neck of the sac for about an inch, and leave the portion surrounding the testicle to form a tunica vaginalis, while the upper portion is carefully dissected up to a point within the peritoneal cavity; it is then ligated, the superfluous portion is cut away and the stump permitted to retract into the peritoneal cavity, as in case of the acquired hernia. It is thus only necessary to close the skin and the opening will close completely in from four to six weeks if the child is kept in bed with the foot of the bed elevated.

If it is possible to reduce a strangulated hernia in children by taxis, the irritation, caused primarily by the strangulation and secondarily by the manipulation, seems to favor closure of the hernial opening. We have repeatedly seen this occur within six weeks if the child was kept in bed in the partly inverted position.

Unfavorable cases. The most unfavorable cases are those in which the abdominal walls are congenitally weak, a condition which seems to be hereditary in many patients. Again, of these cases those in which there are three distinct areas of weakness—the abdomen of three hills described by Malgaigne—seem to be least favorable of all. In this class surgical treatment may become necessary, and here it is well to perform the typical Bassini operation, or that described by Ferguson, the important point in the operation being to secure an accurate closure of the inguinal canal to make up for the natural deficiency in the tissues. Two precautions should be borne in mind: 1, The stitches should be tied very loosely, in order not to cause pressure-necrosis of the already weakened tissues. 2, The tissues of the cord in the male should be manipulated very carefully for fear of causing an atrophy of, or preventing the full development of, the testicle. This is especially important in these cases because herniæ in this class of patients are very likely to be double, and if both testicles should atrophy the patient would be permanently injured. In this class frequently no truss will retain the hernia.

There is but one other condition which justifies the operative treatment of hernia, in children, and that is when, on account of adhesions, the hernia, although not strangulated, is still irreducible. In this class a truss cannot be worn with benefit because it presses on the hernial contents, usually omentum, instead of the empty canal; moreover, the opening not being empty, its closure is necessarily impossible unless the adhesions are absorbed, which, if occurring at all, necessarily requires a long period of time. In this variety of hernia, unless it be complicated with the form just described, it is not necessary to do anything further than in case of strangulated hernia. The hernial sac being removed, the opening will close spontaneously.

In operation for relief of femoral hernia in children it is never necessary to do anything beyond dissecting out, ligating and cutting away the sac, permitting the stump to retract into the peritoneal cavity, and closing the skin. These cases are exceedingly rare. We have never seen a strangulated femoral hernia in a child, and only once an irreducible one due to an adherent omentum, which necessitated an operation.

Use of trusses. Too much stress has been laid upon the importance of trusses in the treatment, and too little on removing the causes, of hernia in children.

It is far easier to retain a hernia and thus encourage the closure of the hernial opening, by first relieving the abnormal intra-abdominal pressure and then applying the truss simply as an aid, than it would be to accomplish the same object by the use of the truss alone.

If it is at all possible it is always best to place the child in bed in the inverted position, and to reduce the intra-abdominal pressure by the methods which have been described, before making use of a truss at all. Then, if it is not possible to maintain this position sufficiently long to obtain a cure it is well to apply a perfectly-fitting truss.

The fact of using a truss does not make the other precautions unnecessary. The child should still be cared for so as to remove intra-abdominal pressure from every cause, and the foot of its bed should still be elevated in order to make use of gravity in keeping the hernia empty and to facilitate the shortening of the mesentery.

Pertinent conclusions. The following conclusions seem to cover the treatment of hernia in children.

1. The development of herniæ in children is favored by: (a) faulty development of the abdominal wall; (b) insufficient strength in the tissues involved in closing the umbilical, inguinal or femoral openings; (c) abnormal intra-abdominal pressure; (d) unclosed condition of the tunica vaginalis.

2. The causes (a) and (b) are likely to be inherited.

3. The abnormal intra-abdominal pressure is due: (a) to gaseous distension resulting from improper feeding; (b) to the exertion necessary to accomplish defecation in case of chronic constipation; (c) to the same exertion necessary to evacuate the bladder on account of obstruction due to phimosis; (d) to severe, long-continued coughs.

4. A large majority of all cases of hernia in children will heal spontaneously if the increased intra-abdominal pressure is relieved, the hernial sac being kept empty.

5. This may be accomplished by means of a truss or, much more rapidly, in inguinal and femoral hernia, by placing the child in bed with the foot of the bed elevated, the time required usually not exceeding six weeks.

6. Children with a tendency to the formation of hernia should be guarded against developing coughs.

7. Their diet should be given at regular times and chosen with a view to avoiding gaseous distension.

8. Constipation should be entirely prevented.

9. In case of boys, phimosis should be relieved, if present.

10. Badly-nourished and badly-cared-for children of the poor should be treated in hospitals, being placed in bed in the inverted position, the cause of increased intra-abdominal pressure being removed at the time by proper treatment.

11. Operation is indicated (a) in strangulated hernia; (b) in irreducible hernia due to adhesions; (c) in case the opening is unusually large in a free hernia, especially if the condition is hereditary and the hernia cannot be retained by means of a truss; (d) in reducible hydrocele.

12. Except in class c, the operation should consist simply in carefully dissecting out the sac, ligating it within the abdominal cavity, cutting away the sac and permitting the stump to retract within the abdominal cavity, and simply closing the wound in the skin.

13. The recumbent position, with the foot of the bed elevated, is of very great importance in the operative as well as in the non-operative treatment of herniæ in children.

14. If the child cannot be kept in this position sufficiently long, a well-fitting truss should be worn night and day until there has been no protrusion for at least six months, at the same time the necessary precautions being constantly taken to guard against intra-abdominal pressure from any cause.

HERNIA IN OLD MEN

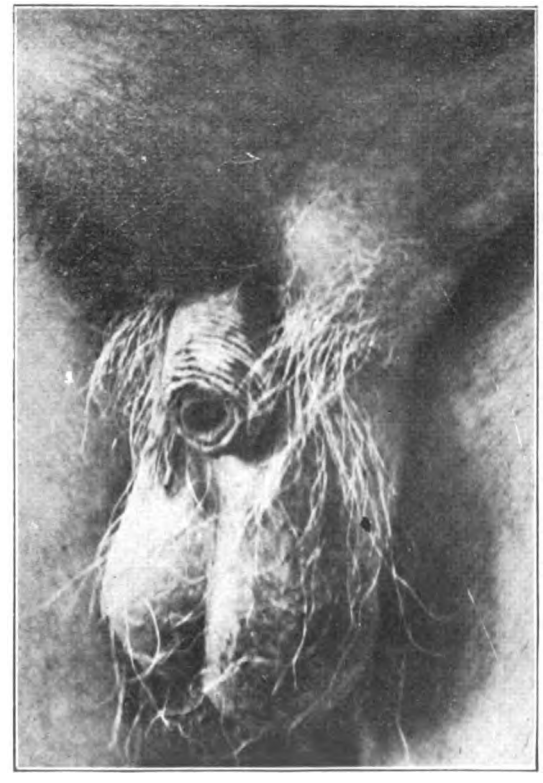
It frequently happens that a male patient can easily retain his hernia by means of a truss until he has attained the age of about sixty years, when he is no longer able to do this, and consequently seeks relief through a surgical operation.

He may have grown obese or his tissues may have become soft and less able to resist intra-abdominal pressure, but there is an important factor in the increased intra-abdominal pressure required in emptying the bladder on account of an obstruction to the passage of the urine, caused by an enlarged prostate gland. This is very common in old men.

In quite a large proportion there will be a rapid reduction in the size of the prostate gland if either a vasectomy or an orchidectomy is done. Both

of these operations can be made very easily in connection with herniotomy without increasing the danger to the patient, and as both remove some of the loose tissue in the inguinal canal they favor permanency of cure in two ways: 1, by making the union between the layers to be united more perfect, and 2, by decreasing, indirectly, the excessive intra-abdominal pressure by reducing the size of the prostate gland.

In many of these cases it is undoubtedly best to perform a perineal prostatectomy as well as a herniotomy. If the patient's general condition is



INDIRECT OBLIQUE INGUINAL HERNIA DESCENDING INTO THE SCROTUM. HERNIA ALWAYS REDUCIBLE. EXTERNAL INGUINAL RING 2 CM. IN DIAMETER. TREATMENT—HERNIOTOMY (FERGUSON-ANDREWS METHOD).

good both of these operations may be accomplished at the same time, if not, it is probably best to make a herniotomy together with an orchidectomy first, and if this fails to produce a sufficient atrophy of the prostate gland to do a prostatectomy later.

If the prostatic trouble is very pronounced so that the patient has to get up several times during the night and strain to urinate, it is well to relieve the prostatic obstruction before operating upon the hernia, for the constant straining is likely to interfere with a perfect healing of the tissues, thus bringing about a relapse of the hernia.

The greatest proportion of strangulation occurs in patients past middle life. It is not uncommon for a patient to have a hernia for forty or fifty years that has always been easily reducible, and then become suddenly strangulated. In the majority of cases the hernial opening increases in size with old

age, and the protusion constantly slips outside of the truss, increasing the patient's discomfort and placing him in constant danger of strangulation.

In operating upon old people one frequently finds that the conjoined tendon has been almost completely obliterated. When this condition exists, it is well to transplant the cord and close the lower angle of the wound as closely as possible. When the obliteration of the conjoined tendon is very pronounced this lower angle can be closed best by opening the sheath of the rectus muscle and utilizing that muscle in the closure, after the method of Bloodgood, as described in a previous section.

STRANGULATED HERNIA

Type of case. A married woman, forty-six years of age, has just been brought to the hospital. From her daughter we learn the following history: The patient has been married for twenty-six years; has never been very strong, but always comparatively well. She is the mother of four healthy children. For many years she has felt a weakness in the region of the left groin and since twelve years old has known of the presence of a femoral hernia, which, however, has given rise to but little distress except when she has worked beyond her strength. Occasionally the hernia has been painful and the patient has experienced difficulty in reducing it, but this has never been serious in character and she has always succeeded in obtaining relief by lying down and applying hot cloths to the part for an hour or two.

Three days ago the patient suddenly became severely nauseated and had great pain in the abdomen. She attributed this to something eaten and imagined that it would soon improve. She consequently made use of home remedies and did not send for her physician until about sixteen hours ago. When he arrived he found the patient very ill. She still continued to vomit, there had been complete obstruction to the passage of gas and feces, the abdomen was moderately distended with gas and the abdominal walls were tense. In the region of the left femoral ring there was a hard mass the size of a hen's egg. The pulse was a little over 100 and the temperature 101° F.

The physician made a diagnosis of strangulated femoral hernia, but as the patient did not suffer from severe pain in the vicinity of the hernia he did not lay very great weight upon this part of the diagnosis. He elevated the foot of the bed in order to make use of gravitation for the purpose of reducing the hernia, gave a hypodermic injection of morphia to relax the muscles, directed the patient to remain in the position assumed and continue the application of hot fomentations. He also forbade the giving of any kind of food by mouth.

The physician then left the patient and returned after six hours, only to find her very much worse in every respect. He then advised an immediate operation, but the husband could not be found for seven hours more, and by the time the latter was convinced of the necessity of an operation the patient was in the present extreme condition. Her face is pale, lips blue, respiration very shallow, pulse imperceptible, and she is without doubt in a dying condition. The pupils are becoming more and more dilated, indicating that death will occur within a few moments.

Such a case is unusually instructive because the conditions present are so frequently encountered in practice.

Prognosis. In the discussion of hernia operated for the radical cure, when not strangulated, the fact was pointed out that the operation is almost absolutely safe, the death of a case depending upon an accident. The same is true in operation for the relief of strangulated hernia at the beginning of the attack, because the only additional element, the strangulation, may be relieved without difficulty and without danger to the patient so long as there has been no injury to the strangulated intestine. Consequently every death following a strangulated hernia—barring the accidents which may occur in connection with any operation—is due to the fact that a physician has not been called at the beginning of the attack, or his advice to obtain immediate relief has not been accepted, or the physician himself has wasted valuable time.

Prompt operative measures necessary. There can be no doubt but that all temporizing in the treatment of strangulated hernia should be strongly condemned, because cases in which relief is obtained in this manner could all be relieved by manipulation of the hernia under an anesthetic, and those that are not relieved would recover were they operated early. Every year thousands

of patients lose their lives unnecessarily from strangulated hernia because time is wasted either on account of their own ignorance or stubbornness, or because of carelessness in examination by the physician called or his lack of decision in obtaining relief at once. Moreover, it should be remembered that any practitioner who has sufficient intelligence and training to have clean hands and instruments, and a fair knowledge of what to do, will save a larger proportion of cases suffering from strangulated hernia by operating at the beginning of the attack than will a surgeon of the very greatest skill and training after the tissues involved have become gangrenous.

A lay misunderstanding. At this point we wish to make a suggestion which seems to be of great practical importance so long as patients and their friends are justly afraid of surgical operations for the relief of strangulated hernia because many of their friends who have submitted to this operation have not recovered. It is difficult for the layman to understand that his friend died, after an operation for the relief of strangulated hernia, because the operation was performed when he was already in a hopeless condition; for this fact should have prevented the operation which was at least useless, as was shown by the result. It is difficult for him to understand why his own chance of recovery should be better than his friend's, inasmuch as his friend was urged to submit to an operation with the same arguments that are being employed in his case. In other words, the large number of deaths following operations for strangulated hernia, where the operation had been postponed until the patient was in a hopeless state, prevents the operation in the case under immediate consideration until it, likewise, is too late to be of value.

This prejudice can usually be overcome in the following manner: Describe to the patient the condition which is present; tell him that a loop of intestine is caught in a ring and constricted as tightly as his finger would be were a string tied about it sufficiently firm to prevent all circulation of blood. He will understand that this must soon be followed by death of the tissues and that then the contents of the intestines will leak into the abdominal cavity and that will be followed very speedily by his death. Tell him that you will make every effort to reduce the strangulation by manipulating the tissues, in order to induce the intestine to slip back through the ring.

Taxis. Place the patient on a couch or a board, or if this cannot be obtained take a door out of its frame and lay the patient on it; then elevate the lower end of this so that it will be at an angle of about 40° with the floor. Have him draw up his knees and then manipulate the protruding portion gently, so as not to cause any injury to the intestine, remembering that the longer the strangulation has existed, the more gentle must be the manipulations.

It is well to permit the patient to manipulate the hernia himself while he is in this position, because he is frequently more experienced, and consequently may be more successful than the physician. If reduction is accomplished, it is well, if not, it is best to explain to the patient that by relaxing the muscles, by the use of an anesthetic, you may still be successful, but if this fails, it will become necessary to sever the circular band which prevents the reduction of the hernia.

This will seem so reasonable to the patient that, in our experience, with only one exception, the patient has always consented when the conditions have been placed before him in this manner. One substitutes the object, namely, the reduction of the hernia, for the operation in the mind of the patient. This is really important.

Operative preparation. It is best to permit the patient to continue in the inverted position while the necessary preparations are being made, which should be very simple, as described in the section on preparation for operation.

If a colleague is available he should be called in the meantime, if not, this should not interfere with the plan of action, because time is the element of greatest importance in these cases.

If the patient is in a hospital it is wise always to anesthetize the pharynx by spraying it with a four per cent. solution of cocaine in water, then insert a stomach tube and carefully wash out the stomach, because these patients frequently vomit during the operation and inspire the offensive material which has decomposed in the stomach, a pneumonia perhaps resulting. In a private house, especially in the country, these preparations may not be possible although it is well always to carry a stomach tube. In this case the patient may be protected by being kept in an exaggerated Trendelenburg position throughout the anesthesia, because in this way the vomited material will escape from the mouth by gravitation before it can be inspired.

When the patient has been thoroughly anesthetized another attempt may be made to reduce the hernia by manipulation, and if this fails, herniotomy should be performed at once. During these manipulations it is again necessary to bear in mind that if the strangulation has lasted only a few hours a considerable amount of force may be exerted with safety, while it is not wise to use any force if the strangulation has existed for more than twenty-four hours for fear of rupturing the intestine.

Symptom resumé. Before describing the operation we wish to direct attention once more to the above history, which is quite characteristic in many respects. 1. The onset was sudden. 2. There were severe spasmodic pains in the abdomen. 3. The patient suffered from nausea and vomiting and consequently attributed her trouble to an error in eating. 4. There has been complete obstruction to the passage of gas and feces. 5. There was a history of the presence of a hernia. 6. A mass existed in the groin. 7. The patient felt severely ill from the beginning. 8. She went into a hopeless condition of collapse very suddenly.

The physical examination, when first seen by the physician at the beginning of her collapse, showed a patient with a bad facial expression, the tongue was thickly coated, temperature and pulse not very high, but the pulse bad in character, the patient was restless, the abdominal walls were tense, the abdomen somewhat distended with gas. The peristalsis of the small intestines could be distinguished through the abdominal wall to some extent. There was complete obstruction to the passage of gas and feces. In the inguinal region there was a very tense swelling which could not be reduced.

Differential diagnosis. The history of a reducible hernia which had existed for a considerable period of time, and the presence of an immovable mass in the inguinal region at the point at which the reducible hernia could be located by the patient, would in itself warrant a positive diagnosis of strangulated hernia in the presence of complete intestinal obstruction.

Without the previous history of a reducible hernia the mass in the groin might be due to a severe inflammation of the inguinal lymph glands. We have seen a case of acute intestinal obstruction due to perforative appendicitis, complicated with bubo, in which the latter might have been diagnosed as a strangulated hernia had not the attending physician treated the patient previously for a specific urethritis. The most common mistake in diagnosis is that of acute gastritis, because the physician is willing to make a diagnosis from the history alone without making a physical examination of the abdomen, the patient either neglecting to mention the fact of having a hernia or this fact being passed over without notice. An acutely inflamed tumor in this region may be mistaken for a strangulated hernia.

In quite a number of these cases which have come under our observation the patient insisted that the hernia had been irreducible for many years and

that it could consequently not be the cause of the severe gastric disturbances. Moreover, the attack came on directly after some indiscretion in eating and must consequently depend upon this and not upon the hernia, which had remained unchanged. The unusual hardness of the hernia is supposed to correspond to the tension in the abdominal walls, due to the intra-abdominal irritation. In this manner a strangulated hernia is mistaken for a simple irreducible hernia which is caused by the adhesion of a portion of the omentum within the hernial sac.

In these cases the operation usually shows that a loop of intestine has slipped into the hernial sac alongside of the omentum and has become strangulated by the sharp ring formed by the connective tissue in the neck of the hernial sac.

A strangulated right inguinal, or femoral hernia, may be mistaken for an acute appendicitis. In several instances we have encountered a gangrenous appendix in a strangulated hernia, and many such cases have been reported.

We have encountered a preperitoneal inguinal hernia, strangulated for one week, containing 20 cm. of small intestine which was strangulated by the thickened peritoneal circular constricting band of the internal abdominal ring. The intestine after passing through this ring had passed between the transversalis fascia and the peritoneum instead of entering the inguinal canal. Here it became gangrenous and perforated without being discovered until the patient was brought into the hospital suffering from hopelessly advanced peritonitis.

A strangulated hernia so small as to be overlooked has been mistaken for every variety of mechanical obstruction of the bowels, but if a careful physical examination is made this is not likely to occur.

In almost every case in which an error in diagnosis is made in strangulated hernia this is due to the fact that the physical examination has not been sufficiently careful.

Etiology. The strangulation is usually due to the fact that a small loop of intestine has been forced out into the hernial sac, which existed previously, by some unusual exertion, and that the connective tissue forming the neck of the sac has constricted the intestine at the point at which it issued from the abdominal cavity, and, interfering with the return circulation the portion of the intestine contained in the sac becomes congested and edematous. The drainage from the lumen of the intestine is obstructed at the same time, which favors the multiplication of micro-organisms contained in the intestinal contents. With the increasing edema the circulation is presently shut off entirely and the loop of intestine becomes gangrenous and perishes, becoming an excellent nourishing medium for the micro-organisms in its lumen.

In the meantime the complete intestinal obstruction has injured the portion of intestine above the constricting ring, because there is a certain amount of tension upon the mesenteric vessels interfering with the nutrition. The pressure within the lumen of the intestines is greatly increased by the accumulation of gas within the bowel, due to the decomposition of the contents which cannot be expelled. Too often this pressure is increased to a marked extent by the administration of food and cathartics by mouth. Presently the distension of these intestines will be sufficient to permit transmission of micro-organisms contained in their lumen resulting in a direct infection of the peritoneal cavity. In the meantime again the infection from the gangrenous intestine within the hernial sac may result in a thrombosis of the mesenteric vessels in the intestine in the peritoneal cavity, causing an extension of the gangrene.

Treatment. From the moment a patient with strangulated hernia comes under care we must absolutely prohibit the giving of food and cathartics by

mouth, because this can only serve to increase the pressure within the intestine and may also serve to force infectious material through the intestinal wall.

If the patient comes under care within the first twenty-four hours it is usually safe to make quite a prolonged effort to reduce the hernia by means of manipulations, the patient lying upon his back with the lower end of the table or couch elevated to an angle of about 40°, with the knees drawn up in case of femoral or inguinal hernia, or with the patient lying flat on his back in case of umbilical or ventral hernia. But even in these cases which come under care early, we must be careful not to injure the intestine by using too much force. If the strangulation has existed much longer, still greater caution, as before mentioned, must be exercised. This is especially true of very small herniæ in which the intestine is often hopelessly destroyed even after thirty-six hours, in which case its return to the abdominal cavity would almost inevitably result in a diffuse peritonitis and death of the patient.

Failing in the reduction, an immediate operation is of course indicated, and this can usually be done directly after the attempt at reduction under anesthesia has been made, without permitting the patient again to gain consciousness.

If possible, it is always best in these patients to perform gastric lavage as described above. Aside from this nothing need be done beyond carefully scrubbing, shaving and disinfecting the field of operation and covering the remaining portions of the body with sterilized towels.

Operative technique. We will here speak of the three common forms of strangulated hernia, femoral, inguinal and umbilical, together, because the same principles apply to all alike.

An incision is made over the center of the swelling, the successive layers of tissue being elevated between two pairs of dissecting forceps in order to facilitate the work by protecting the underlying tissues. If the hernia has existed a considerable period of time the discolored intestine will shine through the hernial sac, which may be smooth and shining, or it may be roughened and adherent to the overlying tissues. This condition is especially likely to be present if the hernia has existed for a long time, and if a tightly-fitting truss has been worn.

Precautions. If the layers are picked up with two pairs of forceps and the incision made only through tissue thus elevated there is no danger of wounding the intestine within the hernial sac. Occasionally one encounters a thick layer of pre-peritoneal fat on the outer surface of the sac which looks so much like omentum that it is quite confusing. It is well to watch for the hernial fluid which can always be found in the sac in strangulated hernia. Frequently there is a sufficient quantity to protect the contents of the sac from injury in making the incision, but quite as often the quantity is very slight: still we believe it is always sufficient to indicate the fact that the sac has been opened.

There is, however, one source of error which has been observed in practice. Occasionally the bladder is drawn into the hernial sac and this has been opened and the urine which escaped has been mistaken for hernial fluid. In case of doubt in this direction it is well to introduce a steel sound into the bladder and examine this organ in the direction of the hernia. In case the accident has happened it is best to suture the wound in the bladder at once with a double row of Lembert sutures of catgut. It is necessary to observe three precautions in suturing such a wound in the bladder: 1. The stitches must be applied with great regularity in order to make the closure impermeable to water. 2. The stitches should not protrude into the cavity of the bladder, in order to prevent formation of stone. 3. They should be tied sufficiently loose to prevent pressure necrosis at any point.

After the hernial sac has been opened and the hernial fluid carefully sponged away, the intestine should be inspected. If this is covered by an uninjured, smooth, shining peritoneum it is likely that it will revive even though it may be quite black. It is not wise to attempt its reduction without enlarging the constricting ring at the neck of the hernial sac because the strangulated loop of intestine has already suffered so severely that it is injudicious to injure it further by unnecessary manipulations.

Cutting the constricting ring. Many methods of cutting the constricting ring have been advised, but unless the operator has through experience acquired especial skill in the use of one of these methods we would advise him to make the incision through all the tissues sufficiently free to expose the edge of the constricting ring and then to introduce preferably a Kocher director between the intestine and the ring and then a scalpel or the blade of scissors between this and the ring, making an incision transversely across the constricting tissues. The strangulation is not usually caused by the tissues of the abdominal wall, but by a hard, inelastic, fibrous ring developed from the tissues composing the neck of the hernial sac.

In femoral hernia it is well to cut inward in order to cut away from the femoral vein. In inguinal hernia it is well to cut in the direction of the inguinal canal, first splitting the fibers of the fascia of the external oblique abdominal muscle, as described in the operation for radical cure of inguinal hernia. If it becomes necessary to cut the constricting band without having it exposed to sight, it is well to insert the finger into the canal in order to determine whether the epigastric artery is in the normal position. If it is, it can be easily avoided; if it is not, it will be best to enlarge the external wound until the constricting portion is in view, when it can be cut safely over a director or over the finger which has been inserted between the intestine and the constricting ring. It is now possible to draw out a further portion of the intestine for inspection. If only one portion has been hopelessly destroyed by the pressure, this will be found just at the point where the intestine was grasped by the constricting ring. Frequently the dark color of the entire loop found in the hernial sac will begin to disappear after the ring has been cut and the circulation in that portion of the intestine becomes re-established.

Determining the vitality of the strangulated gut. Covering this portion with pads moistened with warm, normal salt solution for a minute or more the intestine appears more and more normal and when irritated by touching it the muscles respond by contracting. In such case it is safe to return the intestine into the abdominal cavity and so complete the operation as described under radical cure.

Even if there is no muscular contraction, but a satisfactory return of the circulation, it is safe to return the gut, provided the peritoneal covering is smooth and shining. If, however, there are areas of tissue upon the peritoneal surface which are roughened, or if portions show by their thinness that some of the deeper layers of the intestinal wall are actually necrotic, it becomes necessary to remove the gangrenous portion and to unite the two portions of intestine thus severed.

The upper branch of the intestine is always the one which has suffered most because the peristaltic pressure has forced intestinal contents down to the point of obstruction, consequently this portion of intestine is often greatly distended with gas and feces. Before resecting a gangrenous intestine it is best to make an abdominal section in the median line between the umbilicus and pubis and after cutting away the gangrenous portion of the intestine to bring both clamped ends of the intestine out through the abdominal incision to thoroughly empty the contents of the distended loop by inserting a large glass tube, a purse-string suture having first been passed around the intestine

one or two cm. from the free end to prevent leakage, and then carefully threading the intestine upon the glass tube after the fashion of pulling the finger of a glove upon one's finger. By thus bringing the ends of the intestines out of the wound it is possible to carefully inspect the mesentery in order to determine the condition of the bloodvessels, as well as the peritoneum covering the intestines.

Resection of gangrenous portion. Before cutting away the gangrenous portion of intestine it is necessary to provide against infection of the peritoneal cavity from its contents by carefully placing warm, moist pads of gauze about the loop. Two pairs of long-jawed compression forceps are applied half an inch apart, and two or three inches from the gangrenous intestine, upon the lower segment, which is ordinarily nearly normal, so as to close the lumen of the intestine completely, the points of the forceps reaching about half an inch beyond the mesenteric attachment of the intestine. An incision is made down to the mesentery between these two forceps, then the mesentery of the gangrenous portion of the intestine is transfixed and ligated with catgut. It is best to do this in several sections in order to prevent slipping of the stump.

The intestine is cut loose from its mesenteric attachment and if greatly distended above the gangrenous portion it is well to have the patient rolled over to the side of the operation, and after carefully applying moist gauze pads about the wound to place the end of the intestine which has been cut loose from its mesentery into a basin, to grasp the cut edge at different points with hemostatic forceps and then to remove the long-jawed forceps closing the end of the intestine. In this manner the loosened intestine will act as a tube through which the contents of the upper part may safely be emptied.

In order to obtain a safe point to unite the lower with the upper segment of the intestine it is necessary to sacrifice, in most cases, quite a long piece of the upper segment. It is a better plan to close both cut ends of the intestine and make an anastomosis between the lower segment near its end and the upper segment far enough from its end to be certain that the intestinal walls are quite normal. In this way quite as good a union can be obtained as by resecting a large portion of the upper segment, and much time is saved in the operation, as well as much shock, because the amount of traumatism is very greatly decreased in this manner.

The portion of the upper segment of the intestine below the point of anastomosis remains perfectly harmless.

The methods of closing the ends of the severed intestine and making the anastomosis are fully described in the section on intestinal surgery.

Removal of bowel contents. In other cases in which it is not necessary to make a resection of the bowel, the distended intestine should be emptied after the method of Marks. This consists in placing a purse-string stitch in the wall of the distended intestine making a circle about 1 cm. in diameter, the ends of the stitch remaining loose. An opening is now made in the center of the purse-string area and a glass tube about 2 cm. in diameter and about 30 cm. long is inserted into the intestine and the purse-string is now tied to prevent leakage around the tube. A large rubber tube is slipped onto the free end of the tube and its free end placed in a basin. The intestine is now gradually threaded onto this glass tube and as this is done the intestinal contents are all forced out through the glass tube. A loop of intestine at about the center of the distended intestines should be chosen as a point to insert the tube. The glass tube is first directed toward the upper end of the intestinal canal and this half emptied. The tube is then withdrawn until it can be directed down the lower half of the intestine which is now threaded on the tube, emptying this portion of the bowel. The tube is now removed and the opening in the intestine closed by tying the purse-string stitch and placing a Lembert stitch over

it. This process removes a large amount of septic material from the alimentary canal and leaves the intestine in a collapsed condition.

After-treatment. After operation for strangulated hernia no food should be given by mouth for several days, and then only predigested substance and later broths, soups and milk. The patient may be nourished by enemata consisting of one ounce of some predigested food dissolved in three ounces of normal salt solution given every four hours. Cathartics should not be used until at least a week after the operation, and then only mild salines in small, often repeated doses. Small sips of very hot water may usually be given from the first.

The treatment of the wound must be left to the judgment of the operator. If it seems wise to close the wound this is done in the manner described in operations for radical cure, except in femoral hernia. In femoral hernia the defect made in the ring by cutting the constriction must be repaired in order to prevent the recurrence of the hernia. This can be accomplished very readily with a few interrupted, chromicized catgut stitches. In all other respects the same methods may be followed as in operation for radical cure.

If in any given case it seems unwise to close the hernial opening at once it is well to insert a glass or rubber drainage tube, covered with iodoform gauze, through the hernial opening down to the injured intestine. It has been our practice to withdraw this tube on the second or third day, and after that to withdraw the gauze gradually, by pulling upon it as much as seems wise each day. If the wound suppurates, it is to be treated like an infected wound elsewhere. If it remains aseptic it may be closed by means of secondary sutures a week after the original operation.

This operation must frequently be performed in old and feeble patients, and these do not bear confinement in bed well. It is consequently wise to encourage their moving about in bed and sitting up early.

If a fecal fistula occurs it is well to continue the feeding by enema for two or three weeks, which will usually suffice for a spontaneous cure. If the fistula persists it may become necessary to make an abdominal section for its relief, the technique of which will be found under intestinal surgery.

If the patient seems too weak to bear the operation of anastomosis of the two portions of the intestine, or if the operator who performs the operation does not feel competent to conduct this part of the work, temporary relief may be given by drawing out the intestine for a distance of two or three inches through the enlarged hernial opening, placing strands of gauze between the intestines and the edges of the opening, ligating the mesentery of the gangrenous portion, cutting away the latter and leaving the ends of the intestine open for drainage and leaving the construction of an anastomosis for future consideration.

Important points. The points which should be impressed especially in connection with this subject are: 1. The necessity of always making a physical examination in cases suffering from intra-abdominal pain, nausea or vomiting, and always to examine for hernia in these cases because this will enable the physician to make an early diagnosis. 2. The necessity of relieving the strangulation at once. 3. The fact that these cases are more likely to recover if relieved of the strangulation early by a clean physician or surgeon with little or no experience, than by a surgeon with the greatest possible skill if operated late.

DIAPHRAGMATIC HERNIA

Diaphragmatic herniæ are very rare and when they do exist are seldom diagnosed before the abdomen is opened. The majority of cases that have been reported have been found post-mortem.

Diaphragmatic hernia may be congenital or acquired. The congenital variety is rarely amenable to surgical treatment, because so great a portion of the diaphragm is absent that it is impossible to close the large opening.

The acquired variety may frequently be benefited by operation. These herniæ may follow stab wounds, gunshot wounds and crushing injuries, or they may develop through one of the normal openings in the diaphragm from any cause producing an increased intra-abdominal pressure. The most frequent site for the hernia to take place is through the opening of the esophagus.

The symptoms of diaphragmatic hernia are most commonly those of strangulation of some of the abdominal viscera, but the real cause of the strangulation is rarely diagnosed until the abdomen is opened.

There can be no definite operation planned for the relief of these cases. There is a difference of opinion among surgeons as to the method of approaching such a hernia. Some advise attacking it through the pleural cavity, while others prefer the abdominal route.

In many of these cases the stomach and nearly all of the intestines are found in the hernial cavity.

The very large hernias are hopeless as far as closure of the hernial opening is concerned. In two cases Mayo was able to close the hernial opening by suturing the wall of the stomach to the edges of the opening in the diaphragm and to the abdominal wall and parietal peritoneum in several places. Both patients made a good recovery.

INTRA-ABDOMINAL HERNIA

In text-books little is said of intra-abdominal hernias. This is on account of their infrequency. They do occur, however, and in order to recognize them an understanding of their location is essential. The intersigmoid fossa is found on the under surface of the mesosigmoid at the line of attachment of the mesosigmoid to the abdominal wall and just about the point of emergence of the left iliac artery from beneath the mesentery of the sigmoid colon. Six examples of large hernias into this fossa are recorded in the literature.

Three fossæ are described in the region of the duodeno-jejunal junction, the superior and inferior duodenal fossæ and the paraduodenal pouch of Landzert. Approximately 70 authentic cases of hernia in one of these pouches have been recorded in the literature. Of these 9 were operated successfully. (Unusual Internal Hernias, Nuzum, F. & J., *Trans. Chi. Path. Soc.*, Dec., 1914.)

A very few examples of hernia into pouches about the cecum of the ileocecal junction have been described.

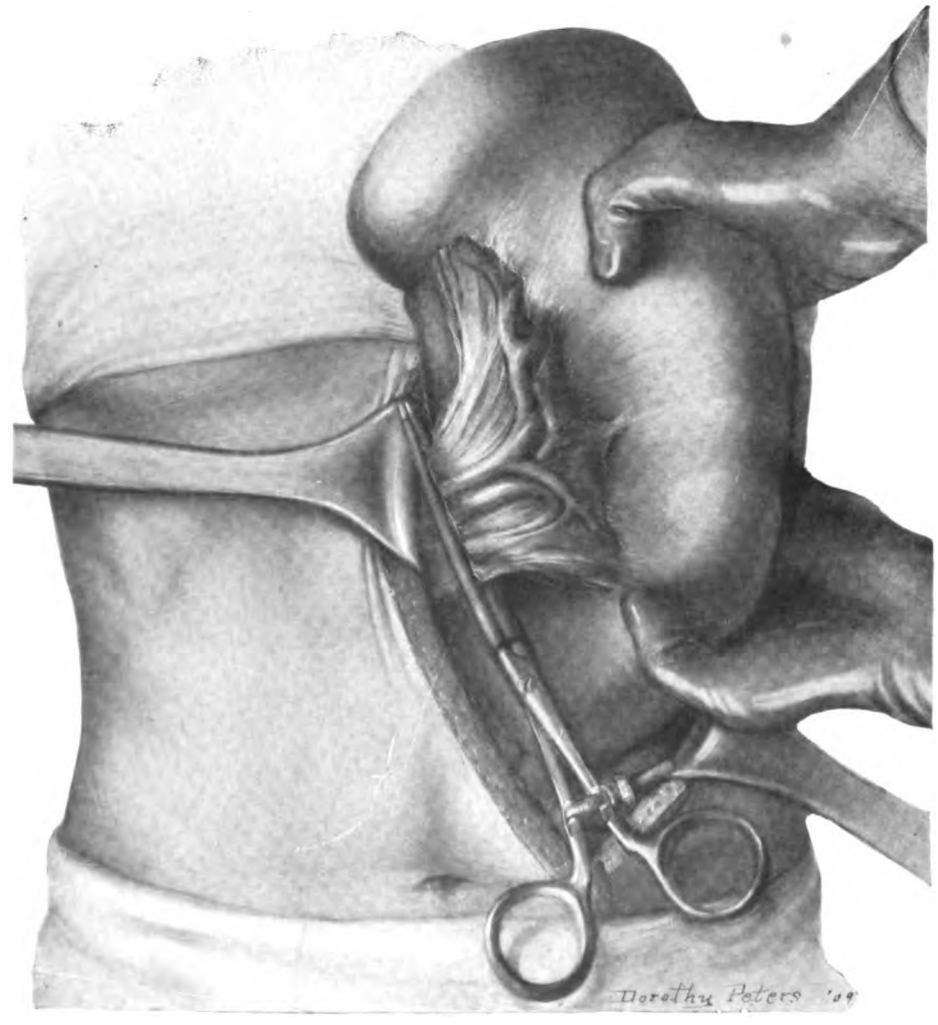
The treatment of each of these types of hernia consists in withdrawing the loops of intestine from the hernia sac, releasing the constriction at the mouth of the sac if necessary, but being cautious not to cut large vessels which frequently are found in the mouth of the sac. The opening into the sac should then be closed in some manner.

SPLEEN

The spleen is the largest of the ductless glands and resembles the other members of this group in that there is very little definitely known concerning its function. It is evident, however, that the spleen does not have an important internal secretion, because of the fact that its removal does not deprive the body of any important constituent, and does not jeopardize the life or comfort of the individual subsequently. There are numerous reports where, in cases of injury of the spleen, a splenectomy was necessary, and after the lapse of many years the patient had apparently suffered no ill

effects therefrom. It is possible that after removal of the spleen, its function is taken up by other organs, especially the lymphatic and hemolymph glands. It is also possible that the thymus and liver may compensate to some extent for the loss of the spleen, as changes in both these organs have been noted following splenectomy.

It is a clinical fact that in the majority of patients suffering from infectious



SHOWING VESSELS OF SPLEEN CLAMPED BY LONG FORCEPS, JAWS PROTECTED BY RUBBER TUBES. (MAYO.)

diseases, the spleen is enlarged, often to the extent of being palpable. The significance of this enlargement is unknown, but it has been suggested that the spleen, with the other lymphatic structures, acts as a barrier, thus protecting the body against micro-organisms and their products. It has also been suggested that after splenectomy patients are more susceptible to the current infectious diseases. It is doubtful whether or not this be true. It has frequently been observed that the resistance against infectious diseases,

once they are contracted, is not evidently affected by splenectomy. One of the writer's patients, who had been splenectomized seven years previously, contracted pneumonia. The disease terminated favorably in the usual manner. Another patient whose spleen had been removed six months previously, contracted typhoid fever, running a typical course of the disease, making fully as rapid a recovery as the ordinary case.

Notwithstanding the fact that an immense amount of research work has been done regarding the physiology and function of the spleen, especially by Pearce and his co-workers, one is impressed with the confusion that still exists. Very little has been attained that would aid us in determining the course of treatment in diseases apparently due to abnormal functioning of the spleen. We still must depend mainly upon clinical observations to guide us in the procedures to be pursued in these cases. With the increasing number of splenectomies during the past four years, there is now enough clinical evidence to show that there are numerous maladies in which splenectomy may be indicated, the most important of which are as follows:

SPLENIC ANEMIA. (BANTI'S DISEASE)

Banti first described this form of anemia, the characteristics of which are a primary splenomegaly, with secondary anemia, later followed by cirrhosis of the liver and ascites. The disease is a chronic affection, with a progressive remittent enlargement of the spleen, often extending over a period of many years. The etiology of the disease is still unknown. The onset is very insidious, and frequently the only detectable symptom at first is an enlargement of the spleen. This enlargement may be present for several years without giving rise to any other symptoms, even the blood picture remaining normal. After the anemia develops, there is no pathognomonic change in the blood picture. It is an anemia of the secondary type, in which the hemoglobin percentage is usually correspondingly lower than in other secondary anemias. There is usually a leucopenia present, the average count being between 2,000 and 5,000. A differential count of the white cells shows no characteristic changes. One of the rather typical features of the disease is the occurrence of recurrent hemorrhages from the stomach. It is not uncommon for a gastric hemorrhage to be the first symptom noted, occurring before the enlargement of the spleen has been noticed. Frequently there are no previous symptoms, gastric or otherwise, and after the patient recovers from the immediate effects of the hemorrhage, which may have been severe, he may again become symptomatically well.

Treatment. Temporary improvement can usually be obtained in splenic anemia by drug therapy, the arsenic and iron compounds being chiefly used. The improvement is only temporary, as the symptoms are certain to return. The disease being primary in the spleen, splenectomy naturally seems to be the rational treatment. During the past few years a comparatively large group of cases has been splenectomized, the results of which have been very gratifying. In considering the treatment it is important to bear in mind that the disease is primary in the spleen, with a chronic enlargement, and that invariably this is followed by cirrhosis of the liver. Furthermore, that removal of the spleen not only relieves the anemia, but prevents the later development of cirrhosis of the liver.

Thus it is important that a splenectomy be made early in the disease, before these secondary changes have taken place. Splenectomy as a curative measure has been so definitely established, that one is justified in saying that removal of the spleen should be made in every case of splenic anemia as soon as the diagnosis is made. Even in the advanced stages of the disease, with

cirrhosis of the liver, it is surprising what a marked improvement follows splenectomy, and some of these cases are even apparently cured. Patients that are anemic and weak stand the operation remarkably well. If the anemia is very pronounced, one or more blood transfusions will increase the patient's resistance and greatly lessen the risks of the operation.

GAUCHER'S DISEASE

This rather uncommon disease resembles splenic anemia very much; in fact, clinically it usually cannot be differentiated from Banti's disease. It is characterized by a gradual enlargement of the spleen with development of a mild secondary anemia, and later enlargement of the liver. Pathologically the disease differs from splenic anemia in that the enlarged spleen is an endotheliomatous growth, and later in the disease growths of the same character are found in the liver and other organs. Gaucher considered the condition a primary epithelioma of the spleen, but Wilson, at the Mayo clinic, points out the fact that it fails to show the attributes of malignancy, but rather a form of hyperplasia resembling that observed in the thyroid. This probably explains the fact why the prognosis is better than that of malignancy. It has been shown clinically that the prognosis is good following a comparatively early splenectomy.

The blood picture is not characteristic and resembles that of splenic anemia. There is a relatively slight anemia, with a progressive decrease of the hemoglobin percentage. Leucopenia is usually present with a relative decrease of the polynuclears.

The disease is more common in women than in men, while splenic anemia occurs a little more frequently in men than in women. Gaucher's disease usually begins before the thirtieth year and runs a chronic course, often covering a period of twenty-five years. The treatment is the same as in splenic anemia. If the spleen is removed before terminal changes take place in other organs, the prognosis is good and the patients are apparently cured.

HEMOLYTIC JAUNDICE

Hemolytic jaundice is a chronic disease characterized by the presence of a mild chronic icterus, with or without an indefinite weakness and malaise, with intermittent attacks of a so-called "crisis" during which attacks there is a marked increase in size and tenderness of the spleen, accompanied by an intense hemolysis, and malaise and usually some temperature. The jaundice becomes quite marked, but differs from obstructive jaundice in that there is no pruritus, no petechia, and is of a light lemon color. Bile will be found freely in the stools, but not in the urine. The acute symptoms of the attacks, which are usually spoken of as bilious attacks by the patient, usually last from two to four weeks, but the increased icterus may persist for several months. The intervals between attacks may vary from a few months to a year or more. A marked acute secondary anemia results from each crisis, varying greatly in degree. The red count may fall as low as one million, but as soon as the acute symptoms subside usually rises rapidly to three or four million, often to a point only slightly less than normal. There is nothing characteristic in the blood picture.

Hemolytic jaundice is of two types, the acquired and the familial or congenital type. The symptoms in the congenital type differ in no way from the acquired type, except that the latter progresses more rapidly, the crises are more severe and at shorter intervals, the disease being more apt to result fatally. In the familial type, the symptoms may persist for years or a life-

time, the patient remaining in a fair degree of health, although suffering at times from the mild crises as previously described.

Treatment. Medical treatment has failed to alter or ameliorate the condition. On the other hand, the results from splenectomy have been so good that the procedure should be recommended in all these cases, as it results in an apparent cure in those who survive the operation. The choice of time for splenectomy in hemolytic icterus is important. The operation should not be done during one of the periods of crisis. When the spleen is removed in the free interval between the crises, the mortality should be extremely low.

SPLENOMEGALY WITHOUT ANEMIA

While splenomegaly is only a sign of one of many disorders, this condition may exist for many years without any apparent injury to health. In some of these cases the only symptom present is that of enlarged spleen, which in some instances becomes so large as to be a great burden to the patient. It is likely that some of these cases are really a mild chronic type of splenic anemia, in which the symptoms are so slight that a definite diagnosis cannot be made. In this type of case, if the enlarged spleen cannot be reduced in size by a thorough course of treatment with arsenic, quinine or the iodide of potassium, a splenectomy is indicated.

The author removed the spleen in this type of case seventeen years ago. The patient has been under observation frequently since that time and has shown no ill effects from the loss of his spleen. Seven years after the operation he had an attack of pneumonia, which took a normal course, and during this attack examination of his blood showed the same condition as in other cases suffering from pneumonia at the same time in the same hospital ward.

SYPHILITIC SPLENOMEGALY ACCOMPANIED BY SECONDARY ANEMIA

This condition may simulate splenic anemia, with which it is very likely to be confused. In all cases of splenomegaly it is important that a Wassermann test should be made, and in the history a careful search made for any evidence of infection, in order to exclude syphilis as far as possible.

Mayo first called attention to the fact that in some of these cases the symptoms will persist in spite of all forms of anti-syphilitic treatment, until after the removal of the enlarged spleen, when the anemic symptoms disappear and the Wassermann test remains negative. From this it would seem that in cases of splenomegaly associated with syphilis, the symptoms of which are not relieved by thorough anti-syphilitic treatment, a splenectomy is definitely indicated.

MALARIAL SPLENOMEGALY

The spleen becomes acutely congested and enlarged during an attack of malaria. This enlargement disappears after the attack subsides, but in some cases repeated attacks result in a permanent enlargement of the spleen, often becoming quite large. Malarial splenomegaly is more prone to rupture than any other type of enlarged spleen. The authors have found that practically all of these cases, even when the spleen is very large, will yield to the systematic use of quinine and arsenic.

The former remedy should be given in solution in two-grain doses every two hours night and day for twenty-four doses, then one-fiftieth of a grain of arsenious acid should be given at intervals of three hours, six times daily,

for six days, then the course of twenty-four two-grain doses of quinine should be repeated. This method insures the presence of fresh quinine in the body constantly and is much more effective in these chronic cases than when given in larger doses at longer intervals; indeed, many cases in which enormous doses of quinine were given from two to four times a day had no permanent effect after treatment for weeks or months, have recovered after a few courses of treatment by this method. We have had an opportunity of testing this method in a large number of cases of chronic tropical malaria and have found it absolutely reliable. It is well to give these patients two ounces of castor oil in the foam of malt or beer daily during this course of treatment, in order to ensure perfect absorption of the remedies.

Some authorities have found it impossible to destroy the plasmodium in the spleen and relieve the chronic anemia by medication, and have resorted to splenectomy. Jonnesco reported a number of splenectomies for this condition, with the result that all the patients who recovered from this operation were cured.

TUBERCULOUS SPLENOMEGALY

The spleen may be the seat of primary tuberculosis, but it more often occurs as a complication of general tuberculosis, especially the miliary form. Cases have been reported in which the tuberculous spleen was followed by general hyperplasia of the lymphatic tissues. In such instances the condition is apt to be mistaken for a lymphadenoma. The blood picture is not at all characteristic. The author encountered one case of tuberculosis of the spleen, which was apparently primary, the only symptoms being general weakness, considerable tenderness and some pain in splenic area, spleen extending about three fingers below costal margin. Slight afternoon temperature was present. The blood picture was one of a mild secondary anemia. Removal of the spleen showed numerous tuberculous nodules and caseous masses with areas of fibrosis. It is now seven months since the operation; the patient has exhibited no signs of tuberculosis elsewhere, and general health is good.

CHRONIC SPLENITIS

This is not an uncommon condition and may occur as a complication of various infectious diseases. The spleen is generally supposed to collect various parasites and send them to the liver for destruction. Under certain conditions the spleen does not seem able to rid itself of these infections, which results in a chronic splenitis and splenomegaly. This condition is practically always associated with a perisplenitis. There is usually quite marked enlargement of the spleen, and considerable discomfort and pain in the splenic area, radiating in various directions. The pain is aggravated by pressure, such as lying on the left side, and is often aggravated by deep breathing. Exacerbation of the symptoms and splenomegaly are quite common, the interval varying from a few weeks to several months. The blood picture may be practically normal or one of a mild secondary anemia. It is the author's experience that the chronic recurrent splenitis does not yield to medical treatment, and eventually has to come to operation. The results from splenectomy in our hands have been excellent.

WANDERING SPLEEN

Occasionally a spleen will become extremely movable so that it may be dislocated to all parts of the abdominal cavity. This may be accompanied by a

considerable amount of suffering in the form of acute pain and digestive disturbances.

In these cases the phreno-splenic ligament is drawn out so that it no longer serves as a support, and the other peritoneal support is equally useless. This pedicle may become twisted and may give rise to severe pain or even collapse. It may give rise to a diagnosis of acute mechanical obstruction of the intestines.

Operation. The outer edge of the wound is retracted thoroughly and a pouch formed out of the parietal peritoneum and transversalis fascia sufficiently large to conveniently hold the spleen which is sutured in place. What is left of the phreno-splenic ligament is utilized in fastening the spleen in this position. In performing this operation care should be taken not to do anything which might interfere with the blood vessels in the gastro-splenic omentum.

In case the pedicle has been twisted, or the operation just described does not promise permanent relief, it is best to remove the organ, which can be done with the greatest ease in these cases by simply ligating the pedicle and cutting it off two cm. beyond the ligature.

These patients do not suffer from the loss of this organ.

PERNICIOUS ANEMIA

Pernicious anemia is a recent acquisition to the field of surgery, but there is not sufficient evidence yet to say that any case of pernicious anemia has been cured by surgery alone. It is evident that the essential pathological process is not in the spleen, yet there is enough clinical evidence to show that the spleen may be a factor of considerable importance.

In the study of sixty cases of pericious anemia, we have been impressed with the importance of a few signs and symptoms as found in these cases.

(a) Hydrochloric acid. In all cases in which the test was made, with one exception, a complete absence of free hydrochloric was found in the fasting contents and in the specimens of test meal. The exception was a very early case and showed a very low hydrochloric acid content. A few cases were in such an extreme condition that it was not deemed advisable to subject them to the strain of passing a stomach tube. The absence of free hydrochloric acid occurred with such regularity that one would hesitate to make a diagnosis of pernicious anemia in any case showing hydrochloric acid, unless it be a very early case and the acid count very low. At the Peter Bent Brigham Hospital in Boston several cases were worked up and found to have an anacidity. The blood was carefully examined, including estimation of hemoglobin percentage, a red, white and differential count, and found negative. Subsequently, these cases returned to the hospital with well-defined pernicious anemia.

(b) Tongue. The appearance of the tongue was noted in every case, which revealed a peculiar, smooth, glassy surface. In some cases this appearance was present only on the sides of the tongue. This condition of the tongue is one of the most important external signs of pernicious anemia.

(c) Pigmentation. Pigmentation was found to be present in the majority of cases, especially on the backs of the hands. The pigmentation may be diffuse or freckle-like.

(d) Hypertension (chronic nephritis) frequently coexists with pernicious anemia. A high blood pressure was found in the majority of patients of middle age or beyond. The hypertension persists, but not quite as marked, through periods of severe weakness, only letting down when the patient becomes extremely ill. For instance, it was noted in a patient in the terminal

stage, that the systolic pressure dropped from 230 to 80 in three days, death resulting on the fourth day.

(e) Temperature. The finding of temperature, of a septic, picket-fence type, was quite common. When this is accompanied by diarrhea it is a very grave symptom.

(f) Diarrhea and vomiting. Diarrhea and vomiting was noted frequently and found difficult to control by medical means. These cases yielded readily by being given a transfusion of 600-800 c.c. of blood, followed by the administration of large doses of hydrochloric acid and bismuth. The vomiting invariably stopped immediately following the transfusion, and the diarrhea usually subsided within a few days. In a few instances attacks of diarrhea was the first symptom of the disease noted by the patient.

(g) Nerve symptoms. The nerve symptoms noted were many and varied, ranging from the most common, that of tingling in the fingers and toes, to those simulating tabes and multiple sclerosis. Marked psychical disturbances were also noted in some cases.

The tongue sign, the pigmentation and the hydrochloric acid test occur with such constancy that their presence may often be the deciding factors in the diagnosis in which the blood picture is a border-line one.

Etiology. While the etiology and pathogenesis of pernicious anemia is still a perplexing problem, it seems evident that besides a condition of increased hemolysis, there is some toxic action on the bone-marrow. From our study of these cases we have been impressed with the value of the observations of Hunter, with respect to the toxic, or even infectious, nature of the disease.

All of our cases have been studied for the existence of a chronic infection, and in practically every one infective foci were demonstrable. The regions in which foci were found are namely: The gall-bladder, appendix, and about the mouth and throat. Just what effect this chronic low grade infection may have upon the hematopoietic organs, is still an unanswered question. The spleens removed have shown evidence of a chronic splenitis and usually perisplenitis, indicating that a toxic or infective process had been present there.

Treatment. In view of the fact that pernicious anemia is, in all probability, a disease of infectious origin, and that the spleen has abnormal hemolytic action on the blood elements, with a late bone-marrow exhaustion, we have been more and more firmly convinced that the rational treatment in selected cases consists of three main factors, viz.: (a) massive step-ladder transfusions of whole blood, (b) splenectomy, and (c) removal of all possible sources of infection.

Each of these steps plays an important part in the treatment. The repeated blood transfusions nourish and stimulate the bone-marrow to action and help to restore the secondary changes in the various organs; the splenectomy unquestionably reduces the amount of blood destruction; and the removal of the various foci of infection will relieve the patient of a chronic toxemia, and possibly of an etiological factor of the disease.

Indications for operation. In analyzing the various patients that have been splenectomized, it is evident that certain cases are unsuitable for operation. The degree of anemia present is of less importance in determining operation than the clinical manifestations of the disease. Patients showing nervous or mental symptoms or evidence of pathological changes in the spinal cord, probably should not be considered as surgical. While in these cases the blood picture will often be improved for a considerable time, it does not seem to interrupt the degeneration that is taking place in spinal cord and central nervous system. Splenectomy should not be attempted during an exacerbation of the disease, especially if this be accompanied by a severe diarrhea,

which is often the case. In the majority of cases, however, by a series of blood transfusions, the exacerbation can be rapidly changed so that in three to five weeks the case will be suitable for operation. Patients with temperature, recent hemorrhage, or purpuric eruption, should not be operated unless these symptoms disappear following a series of blood transfusions.

Operation should be considered in all other patients as soon as a positive diagnosis of pernicious anemia is made, and all conditions which might be a factor in producing anemia, which can independently be relieved, have been excluded.

The transfusion of blood has recently received a great deal of attention and has been advocated by some as the sole means of treating pernicious anemia. Its employment will result in marked temporary improvement in the vast majority of cases. Our experience has been that, while the blood picture will improve immediately in practically every case, and that in some early cases a very prompt and marked remission will take place and may persist for a period of several months, on the other hand, in the late cases, the improvement in the blood picture from the transfusion alone is very transitory, as the blood will begin to decline within a period of two to three weeks, unless transfusion is repeated.

The immediate effects of transfusion are usually quite striking. The red blood count is increased, often doubling immediately if the count is very low; the hemoglobin percentage rises, and the number of platelets is increased. The blast cells usually become more numerous, and occasionally Howell's particles will appear in the blood, indicating a stimulation of the bone-marrow.

It is evident that the transfusion of large masses of whole blood accomplishes more than the mere mechanical addition of so much blood. It seems that it actually exerts either a curbing influence upon the hyperactive spleen, or a stimulating action upon the bone-marrow, since the blood picture continues to improve for several days after transfusion. This may be due to the fact that the blood-forming organs are not only overworked, but are also undernourished. Furthermore, the multiple blood transfusions supply protective antibodies and assist the patient in getting rid of the secondary changes which have taken place in the various organs. During the period that the patient is being prepared for operation by multiple blood transfusions, he should be treated in regard to any self-evident infection.

The patients begin to improve immediately after the first transfusion, and continue to improve with each subsequent one, until they are good surgical risks, and splenectomy can be done without greater shock than would be produced in any other patient by an operation of the same magnitude.

From the study of the numerous cases of pernicious anemia that have been operated during the past four years, it is evident that removal of the spleen stops only temporarily the progress of the disease in the vast majority of cases. The authors have had one patient in whom there has been no return of symptoms three and one-half years after splenectomy, and four others without recurrence of symptoms a little over two years since operation.

While no surgeon can say that a cure has resulted from splenectomy or other surgical procedures in any case of pernicious anemia, still there is enough clinical evidence to show that the benefits derived from surgery are more than by any other means. This evidence, and the comparatively low operative mortality, together with the utter failure of other means to combat the progress of the disease, are all strong arguments for classing pernicious anemia as a surgical disease.

SPLENOMYELOGENOUS LEUKEMIA

This condition, which has always been looked upon as a hopeless medical disease, is just beginning to attract attention in the field of surgery. The fact that the application of the X-ray over the spleen will not only reduce the enlarged spleen rapidly, but will also decrease the white cells and improve the anemia, has suggested the idea that splenectomy might be of benefit in these cases. Radium applied at several points over the enlarged spleen has a much more rapid effect than the X-ray. The relief is only temporary, both from the X-ray and radium, for as soon as the improvement produced by the X-ray or radium ceases, the increase in white cells and enlargement of spleen will recur. Later on, after one or more exacerbations, the X-ray and radium both lose their power to bring about another remission of the disease. During the past year a few cases have been treated by first reducing the enlarged spleen and lowering the white count by means of X-ray or radium, or by both combined, and then removing the spleen. The immediate results have been satisfactory so far. Time is too short to predict how long this improvement may last.

The authors recently encountered a case of splenomyelogenous leukemia in which the spleen extended well into the pelvis, and the white count was 1,100,000. From the use of radium the spleen reduced very rapidly in size, and the white count dropped from 1,100,000 to 15,000 within eight weeks. A splenectomy was then made, the patient making a rapid immediate recovery. Time is too short to predict what will be the ultimate outcome in this case.

Technique of operation. In pernicious anemia and other conditions where the spleen is not large, we elect the high mid-line incision instead of the usual left rectus, for the reason that, first, other pathological conditions, such as the gall-bladder, appendix, gastric ulcer, etc., may be dealt with; second, this incision can extend higher than any other, namely, to the ensiform cartilage; and third, the pedicle and blood supply of the spleen are readily accessible, since their course is from the mid-line towards the left, thus enabling one to reach them under the spleen's edge, without having to pull the spleen outside of the abdomen. The pedicle of the spleen in pernicious anemia is usually short, and there is less danger of tearing its veins if it is pulled toward the mid-line as it is dislocated and lifted from its bed. If the spleen is extremely large, it is preferable to make the incision through the left rectus muscle.

Having opened the abdomen through an ample incision, a thorough exploration of the abdominal organs should be made, noting the condition of the appendix, gall-bladder and bile passages. Any pathological conditions found in these regions should be dealt with as in any other patient.

A large abdominal pad is placed in the left upper quadrant of the abdomen, keeping the colon and small intestines from the field of operation. The dislocation of the spleen from its location against the diaphragm and left kidney is easily accomplished by gently passing the fingers between the spleen and these structures, keeping the fingers in close contact to the spleen surface during the manipulation. As the spleen is dislocated it is gently rolled toward the mid-line, and a hot, moist pack is placed in the space from which the spleen has been lifted, to control any bleeding, until the rest of the operation is completed. The hemorrhage from the adhesions, even though considerable, in some cases, is easily controlled in this manner. In mobilizing the spleen the tail of the pancreas should be kept in mind, as it is occasionally adherent to the under surface of the spleen and also to its pedicle along its posterior surface. After the spleen has been elevated, the gastro-splenic omentum is caught between forceps and ligated. At the lower pole of the

spleen this is very simple; at the upper pole, where it contains the vasa-brevia, several in number, as they run from the splenic artery to the greater curvature of the stomach, it is much more difficult. The edge of the spleen is frequently in close apposition with the fundus of the stomach in this region. As soon as the vasa-bevia have been ligated, the fundus of the stomach can be depressed and the pedicle of the spleen readily caught with two pair of forceps, the blades of which are covered with rubber tubing. The pedicle is now transfixed with heavy catgut and ligated en masse. The gauze pack is now removed from the space where the spleen was located, and if any bleeding persists from the small vessels torn while separating the adhesions, they are stitched with fine catgut. The abdomen is closed without drainage. If the patient is extremely anemic, a transfusion of 600 to 800 c.c. of blood is given immediately at the close of the operation.

PANCREATITIS

Since the surgeon has come to consider pancreatitis habitually with the same uniform system that he considers all other important intra-abdominal pathologic conditions, our appreciation of its importance, as well as our knowledge of this condition, has acquired reasonable dimensions.

Etiology. Undoubtedly, the infection usually travels up the common duct into the gall-bladder where there is a possibility for the accumulation of a large quantity of infected bile mixed with mucus, which on its way down the common duct is easily diverted into the pancreatic duct if there is obstruction from gall-stones or edema below the point at which the duct of Wirsung empties into the common duct.

In our cases the irritation of the common duct has been due quite as often to the passage of infected sandy bile as to the presence of gall-stones.

There is much difference in the statistics of various authors regarding the relative frequency with which pancreatitis accompanies gall-stones. This is probably due to the fact that the diagnosis of pancreatitis is based on the impression the surgeon obtains from palpating the gland during operation, and one surgeon may consider the gland practically normal in an individual instance in which the same condition would impress another surgeon as representing a certain degree of enlargement.

Unless a surgeon has examined many cases in which the abdomen was opened for conditions which could have no relation with the pancreas, in order to become familiar with the feeling of a normal pancreas, it is not likely that his judgment in this matter can be entirely satisfactory.

It is therefore well to palpate the pancreas in cases of operation for the removal of uterine fibroids or ovarian cysts and other similar conditions. This can be done readily while the surgeon's hand is in the upper portion of the abdomen for the purpose of examining the gall-bladder.

All surgeons with large experience in this special direction seem to agree that pancreatitis patients almost invariably suffer from disease of the gall-bladder or ducts, and that gall-stones in the common duct are more commonly accompanied by pancreatitis than stones in the gall-bladder.

It has been suggested by Williams and Bush, and apparently confirmed by careful experimentation, that anatomic peculiarities interfering with the free drainage of pancreatic juice through the ducts of Santorini or Wirsung provide favorable conditions for the infection of the pancreas. It is plain that when the natural conditions for free drainage of pancreatic juice are unfavorable, complete obstruction, due to the presence of gall-stones or edema, is much more likely to occur.

The colon bacillus is the most common cause of the infection, and is frequently associated with the streptococcus and the staphylcoccus.

Pancreatitis, in common with all inflammatory diseases of the gall-bladder and ducts, frequently follows inflammatory diseases of the gastro-intestinal tract.

After the pancreas has once been infected a species of vicious circle is developed from the fact that the swollen pancreas obstructs the portion of the common duct which passes through the head of this organ, which favors the development of septic micro-organisms above this point as well as their further backing up into the pancreas. It is for this reason that the free drainage due to cholecystostomy has given such uniformly favorable results.

All these facts seem to bear out the theory commonly accepted at the present time that, barring the rare occurrence of metastatic infection, pancreatitis is due to infection from the alimentary canal, usually through the biliary passages, or, according to Maugaret, more especially through the lymphatic system of these passages. The acute violent cases of hemorrhagic pancreatitis are apparently due to retrograde injection of the pancreas with infected bile and pancreatic juice which, according to Flexner, must be in a relatively concentrated form. In these cases which take a violent acute course there is commonly a rapid destruction of the gland parenchyma. In the chronic forms, on the other hand, the inflammation results in interlobular fibrous tissue hyperplasia. The secreting cells of the acini are more readily destroyed than the islands of Langerhans. This fact would account for the relative infrequency of glycosuria in mild or early cases of pancreatitis.

Diagnosis. Until recently the diagnosis of pancreatitis was made incidentally only during the progress of operations on the gall-bladder or biliary tracts and the stomach. Since the attention of surgeons was generally directed to this condition by Mayo Robson, Riedel, Mayo and others, the diagnosis has frequently been made before, and confirmed during, the operation. From this it has become possible to associate the condition of pancreatitis with a number of more or less typical diagnostic signs observed before operation.

In 1904 Cammidge, in connection with the clinical work of Mayo Robson, brought out a most ingenious chemical test which promised to be of great value in the diagnosis of this condition.

The method has been described most clearly by Schroeder, as follows:

Forty c.c. of the urine, filtered, acid reaction, free from albumin and sugar, are boiled with 2 c.c. of strong hydrochloric acid for ten minutes. After partly cooling, 80.0 gm. of lead carbonate are gradually added. When the reaction is complete, the mixture is chilled, filtered and the excess of lead in solution removed by addition of 2 gm. of sodium sulphate bringing the mixture to a boil, chilling and filtering to 20 c.c. To this filtrate is now added a mixture of phenylhydrazin hydrochlorate 0.80 gm., sodium acetate 2.0 gm. and of 50 per cent. glacial acetic acid 1 c.c. and the whole is boiled on a sand-bath for ten minutes. The solution is then filtered while hot and set aside to crystallize. The precipitation of crystals, sometimes only in microscopic quantities, of the characteristic formation of ozazones, makes a positive reaction.

In 1905 we had a large number of tests made at the Augustana Hospital laboratory on patients who were later operated on, so that the findings could be judged as to their reliability by the actual examination of the pancreas. These tests were carried out by Dr. J. L. Yates, then chief assistant, whose large experience as a carefully trained laboratory investigator fitted him particularly for this task. He had, moreover, assisted in the diagnosis, operation and after-treatment of a great number of cases belonging to this special group, so he also possessed a large experience as a clinical surgeon.

These tests were extremely fascinating, but it seemed to us that it required too much of the personal element of the observer to make the method useful except in the hands of unusually skillful experts.

The fact that surgeons like Robson and Moynihan continue to trust this test is, however, sufficiently important to convince us that it contains real merit.

Symptoms. If we add to the well-known symptoms of cholecystitis an area of tenderness from 5 to 10 cm., long, located to the right of the umbilicus over the middle of the right rectus abdominis muscle, in cases in which we can exclude a diagnosis of duodenal ulcer, we have the typical symptoms on which to make a diagnosis of pancreatitis.

In duodenal ulcers there are two symptoms usually present which are not symptoms of pancreatitis: (1) pain before meals when the stomach is empty, and (2) hyperchlorhydria with eructations.

In pancreatitis there is frequently referred pain to the mid-scapular or left scapular regions. In gastric ulcer the same pain is commonly present, but with this there is pain on deep pressure at a point half-way between the ensiform appendix of the sternum and the umbilicus.

There are, of course, cases in which two or more, or all of these, conditions are present in the same patient, and other cases in which it is possible only to determine the fact that one or more of these conditions are present, while a strict differential diagnosis may not be possible. In these cases, however, it is quite possible to determine the necessity of an exploratory incision, and, when the indications for this are not clear, then it is usually safe to keep the patient under dietetic treatment until further study has cleared up the diagnosis.

Solomon has pointed out the fact that in the presence of pancreatitis von Noorden's oatmeal diet gives rise to typical butter stools and that an abnormally large amount of lecithin is excreted. From 0.4 to 1.2 gm. is excreted in twenty-four hours when these patients are placed on an egg diet, while normal individuals excrete not to exceed 0.1 gm. under similar feeding.

According to Schlecht, Mueller's test is quite reliable. The patient is given a test meal which is followed after two hours by a calomel purge. A few drops of the stool are sterilized by heat, then placed on an agar plate containing Loeffer's serum. The plates are kept in an oven at 131 to 141° F. for twenty-four hours. If trypsin is present the serum shows pronounced depressions, if absent the surface is smooth. Lepine has made most interesting but very complicated experiments which he claims are valuable in the diagnosis of this condition.

In advanced cases there is usually marked emaciation, frequently with peculiar circumscribed areas of fat in roll-like masses on the front and sides of the chest and abdomen. There is usually marked anemia present, often approaching chlorosis with degeneration of the erythrocytes. Many of these patients suffer from obstinate constipation, while others have equally troublesome diarrhea.

Sugar is present in the urine of only a small proportion of these cases.

Treatment of chronic pancreatitis. The treatment must consist primarily in relieving the irritation, due to the backing up of infected bile, by establishing free drainage which must be sufficiently permanent to permit complete restoration of gall-bladder and ducts, as well as the pancreatic ducts. It is important to keep the intestines and stomach normal and free from irritation permanently by the use of proper diet and hygiene after these operations.

In case gall-stones or pancreas stones are present, these must be removed, whatever their location may be. In rare cases in which the common duct is permanently obstructed, cholecystenterostomy may be indicated.

It is probably best to make the anastomosis between the gall-bladder and duodenum where possible, and between the gall-bladder and jejunum through an opening in the transverse mesocolon where the duodenum cannot be safely reached. The suture method should be employed similar to the one used in posterior gastro-enterostomy.

Surgical treatment of chronic pancreatitis. In chronic pancreatitis the treatment originally practised and advised by Mayo Robson, consisting in the establishment of perfect drainage through a cholecystostomy opening, seems to be still the best. The edema of the common duct and the pressure and consequent obstruction due to the presence of an enlarged pancreas are thus relieved and with this the pancreas and the liver are simultaneously reduced to a normal size.

The portion of the gland that has been hopelessly destroyed is, of course, permanently lost, but the remaining portions are usually sufficient to perform the necessary physiologic functions if the patient is properly educated in the selection of food.

Acute pancreatitis. It is difficult to make a differential diagnosis in acute pancreatitis with any degree of certainty because there are several other violent acute conditions which are so similar in their symptoms that they can probably never be positively excluded. The conditions most likely to be confounded are (1) perforation of the posterior wall of the pyloric end of the stomach; (2) perforation or gangrene of the gall-bladder or duodenum.

Cases of severe acute pancreatitis have been diagnosed as acute intestinal obstruction, renal colic, ectopic gestation and, of course, appendicitis and gall-stone colic.

Symptoms. In acute pancreatitis the pain is extremely severe in the right upper quadrant of the abdomen. There is intense shock; nausea and vomiting are usually present and the patient gives the impression of being on the verge of dissolution. The abdominal muscles are tense, although Moynihan found this symptom absent in some of his cases. There is usually a steady rise of the pulse from the onset.

There is usually a history pointing to gall-stone colic in previous milder attacks.

If a tumor be felt there is usually tympanitis on percussion over this surface because the gland is located behind the duodenum.

Cyanosis has been observed by Opie and others. Sugar is present in the urine in some cases. Egdahl gives a careful review of 107 cases in his study of the symptons and diagnosis of acute pancreatitis which is well worth the careful consideration of the clinician.

Surgical treatment of acute pancreatitis. In mild cases of acute pancreatitis surgical treatment is not indicated. If the local irritation is removed by making gastric lavage and placing the patient on exclusive rectal alimentation, so that nothing passes through the duodenum for a time, the obstruction to drainage through the common duct will soon subside because of the disappearance of the local edema, and then the conditions will be favorable for recovery from acute pancreatitis.

The correctness of this view must be plain to every one who has operated on a large number of patients suffering from acute gall-stone impaction in the common and cystic ducts, at various periods during these attacks. If an operation is performed during the attack the simple drainage of the gall-bladder has always, in our experience, sufficed to relieve the conditions, except in cases in which there existed at the same time a severe acute cholangitis, in which there has been a mortality of about 30 per cent. A moderate degree of cholangitis will subside even if there is marked acute pancreatitis, provided the operation itself does not increase the infection.

The procedure should be as simple as possible and no rough or unnecessary handling of the inflamed tissues should be employed.

Even in violent acute cases of pancreatitis a proportion of patients will recover if the abdomen is quickly opened and simple drainage introduced. Glass tubes covered with gauze, split rubber tubes or cigarette drains may be employed. The number of recoveries depends on the severity of the attack and the promptness with which drainage is supplied. Robson has had nearly 40 per cent. of recoveries. Patients in whom the extravasation of pancreatic juice has caused fat necrosis are least likely to recover. We have seen several of these that have recovered without, and one with, operation and Mayo reports similar results.

Unless jaundice is present it is best to limit the operation to the location and drainage of circumscribed areas of infection or necrosis of the pancreas, to the control of hemorrhage by means of fine catgut sutures, and the free drainage of the entire area. This can best be done through a median or a high right rectus incision. It is important to go over the gland carefully, but it is quite as important not to traumatize the tissues unnecessarily. These patients have but a slight margin of possibility of recovery and this can easily be lost by unnecessary traumatism or prolonged exposure.

If jaundice is present simple drainage of the gall-bladder, with removal of loose gall-stones, is indicated, but it is best not to interfere with stones impacted in the ducts. We lost two patients needlessly before appreciating the folly of doing too much in these cases.

Conclusions. In a general way the following conclusions seem proper:

1. A clinical diagnosis of chronic pancreatitis is usually possible before operation.
2. This condition is practically always a complication of gall-bladder or gall-duct disease, except when following metastatic infection.
3. It is usually curable by relieving the pathologic condition of the gall-bladder and ducts.
4. An operative diagnosis of acute pancreatitis can often be made.
5. Early operation greatly improves the prognosis.
6. It is important to reduce to a minimum the trauma in these cases.
7. The important factor in the treatment consists in the establishment of free drainage.

PANCREATIC CYSTS

In cysts of the pancreas resulting from a total occlusion of the duct thereof, usually due to traumatism, the treatment consists in making an incision either in the median line or through the rectus abdominis muscle. The tumor will be found to be retro-peritoneal, because the pancreas is a retro-peritoneal organ. The surrounding organs are tamponed away by means of moist aseptic pads, then the cyst wall is exposed by making a slit in the peritoneum. The cyst is then tapped with a trocar, then opened and the remaining fluid sponged away with moist pads. Then the cavity of the cyst is tamponed lightly with iodoform gauze and the edges of the wound sutured to the parietal peritoneum and transversalis fascia in the upper angle of the wound. The remaining portion of the wound is closed in the usual manner.

The iodoform gauze is later gradually removed. If there is no secretion after this has been done no further drainage is instituted, but if secretion continues a drainage tube is inserted when the tampon has been removed and this is kept in place until the discharge subsides, which usually occurs in a relatively short time, the cyst becoming obliterated by the adhesion of its walls.

HEMORRHOIDS

Those suffering from hemorrhoids usually give a history of long-continued, habitual constipation. The patient's occupation is usually sedentary and the diet complicated and unhygienic, hemorrhoids resulting from obstruction to the return circulation through the hemorrhoidal veins. This obstruction may be local, due to accumulations in the rectum, or to the presence of tumors in the pelvis. Pregnancy is a common cause, or it may be the result of obstruction in the hepatic circulation.

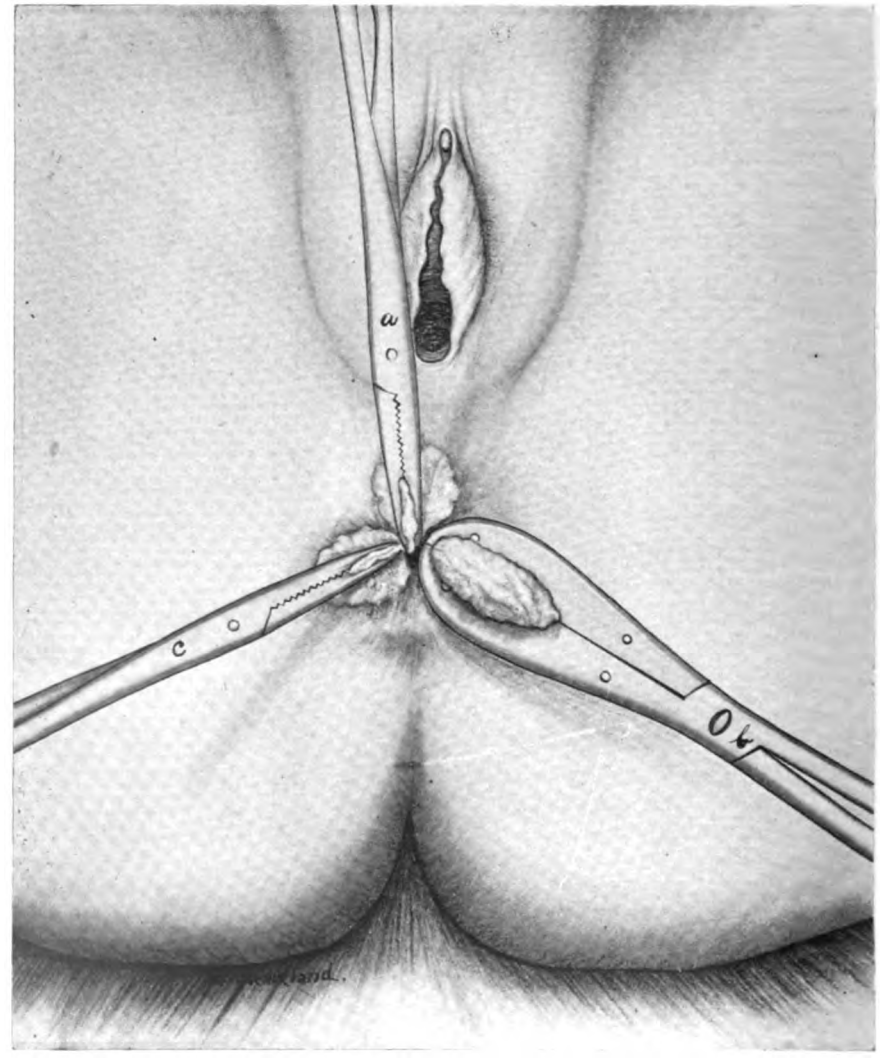
Diagnosis. There is a history of suffering from a sensation of fullness in the region of the hemorrhoidal veins. This may be accompanied by occasional hemorrhages, which give temporary relief to such sensation. If the condition has existed for a prolonged time there is a protrusion of mucous membrane containing distended hemorrhoidal veins at each evacuation of the bowels. These masses may become replaced spontaneously, or may have to be returned mechanically. Upon digital examination soft, oval masses will be felt, varying in number from one to six or eight, although there are usually not more than three or four. Some of these masses are usually larger than others. They sometimes acquire considerable size, rather more than an inch in diameter. In many there is a constant secretion from these surfaces, giving rise, on account of its irritating character, to an eczema. After the hemorrhoids have existed for a time, the patients usually complain of a constant burning sensation in this region.

Treatment. In many cases simply regulating the diet, securing a regular free evacuation of the bowels each day, and applying some soothing ointment or suppository, together with the use of Sitz, or shower, baths, will result in relief. If, however, it has existed for a long time this will usually not suffice, and an operation will have to be employed in order to secure permanent relief.

The patient should be cautioned to eat only easily-digestible food in very moderate quantity, to take a mild saline laxative every day for several days previous to undergoing operation, and on the day before operation he should be given two ounces of castor oil, followed the same evening, and the following morning, with large flushings of the colon. In this manner the alimentary canal can be quite thoroughly freed from material which might otherwise irritate the wound surfaces after the operation.

Operative technique. In our own experience the following operation has proved exceedingly satisfactory in almost every instance. The patient being anesthetized and placed in the lithotomy position the sphincter ani muscles are very thoroughly dilated by introducing the thumbs beyond the internal sphincter and stretching very slowly, but very thoroughly. The slow progress of the stretching will prevent tearing the mucous membrane unnecessarily. The stretching should be continued until the sphincter remains lax after it has ceased. Each hemorrhoid is then caught with two pairs of hemostatic forceps placed in a straight line with the direction of the rectum, the outer one being from one to two centimeters, the second from two to four centimeters, from the margin of the anus. A clamp is then applied to the hemorrhoid beneath the attachment of these forceps, also in the direction of the rectum. If it is convenient a clamp which is protected on its lower side with some bad conductor of heat, such as ivory, bone or rubber, is to be preferred, otherwise an ordinary pair of long-jawed hemostatic forceps will serve the purpose very well. The surrounding tissues should be protected by placing underneath the forceps a piece of asbestos cloth, or if this cannot be procured, a piece of gauze folded half a dozen times upon itself and immersed in cold water may be placed underneath the clamp. A shield may be cut out of ordinary pasteboard and this may be immersed in corrosive sublimate solu-

tion for a moment before using. This is slipped between the clamp and the patient, producing a perfect protection against burning. The projecting portion of the hemorrhoid is then carefully seared by means of a cautery. It is preferable not to cut away the projecting portion, and to cauterize the small



CLAMP AND CAUTERY OPERATION FOR HEMORRHOIDS.

Showing forceps *a* and *c* in place for the purpose of marking hemorrhoidal tumors at beginning of operation; *b* clamp protecting underlying skin by means of ivory plates riveted to lower surface of jaw plates.

portion left beyond the forceps, because if the entire hemorrhoid is thoroughly baked with a cautery not too hot, there is never any danger of subsequent bleeding, which is not the case when the top of the hemorrhoid has been cut off first and the cautery applied later. Any cautery will serve the purpose, but the one which we have found of the greatest service consists in a simple,

small-sized soldering iron, heated in a tinsmith's heater, in an ordinary gas flame, in a coal stove or over an alcohol lamp. It is much more economical than any of the gasoline or electric cauteries, it is never out of repair, and can be easily procured anywhere.

The successive hemorrhoids are then picked up in the same manner and treated alike.

The main vessels come down in three groups, one anteriorly and two laterally. If these are caught in three masses and cauterized, the remaining hemorrhoids will usually disappear spontaneously. It is important in applying the clamps always to leave at least half an inch of normal mucous membrane in order to avoid the production of stricture.

It is not wise to cauterize a hemorrhoid exactly in the median line in front, in a male, on account of its close proximity to the urethra, as it frequently happens, if this is done, that an obstruction to the passage of urine occurs for several days after the operation, which may prove exceedingly annoying; and if a hemorrhoid at some small distance to one side of the median line is caught the one which may exist exactly in the median line, and which may be larger than either of the others, will disappear spontaneously. It happens occasionally that there is but one hemorrhoid, and that this is just in the median line; then, of course, it will have to be clamped in order to secure relief. It is of very great importance that if the clamp and cautery method is used the clamp should always be applied parallel with the direction of the rectum, because if it is applied transversely the patient is almost certain to suffer from the formation of a stricture.

In selecting a clamp it is well to avoid an instrument with sharp serrations, as these would be likely to injure the delicate veins, giving rise to troublesome hemorrhage. Even with a properly constructed clamp care must be taken not to lacerate the veins.

Ligature method. If no clamp of any kind is available, and it is desirable to relieve a patient of hemorrhoids, this may be accomplished by the following plan, which we believe is quite as satisfactory as the clamp and cautery method, but we have not performed it nearly so often, having become accustomed to the other procedure.

The preparatory method and dilatation are the same as in the operation just described. The hemorrhoid is picked up in the same manner. It is then transfixed with a needle armed with double silk or catgut ligature, about thirty to forty centimeters in length. The needle is cut away and the ligature tied upwards underneath the second forceps. With scalpel or scissors the mucous membrane is then carefully cut transversely at the margin of the anus and the second ligature is tied in the groove thus formed. The projecting portion of the hemorrhoid is then cut away, only a sufficient amount being left to prevent slipping of the ligature. This method is applied to each hemorrhoid in succession until all have been removed.

Dressings. The patient is much more comfortable, and the wound will heal quite as satisfactorily, if no dressing is applied after either the clamp and cautery or the ligature method. For a considerable time we habitually applied some form of tampon or drainage to the rectum after operating for hemorrhoids. This was decreased in amount constantly with increasing comfort to the patient, until at last we discarded this form of dressing entirely, and latterly for a large number of these cases no dressing has been used, except a little ordinary pad to the external parts held in place by a T-bandage, for the purpose of absorbing any secretion.

After-treatment. The patient is kept on liquid diet for four or five days. At the end of this time a cathartic is given and before this causes an evacuation a large soap and water enema is administered through a soft rubber catheter.

This is repeated after the cathartic has acted. From this time on a small saline laxative is given every morning, and the evacuation is followed by the soap and water enema. The patient is confined to his bed for about a week.

In unusually severe cases the excision of the entire rim of hemorrhoidal tumors may be practised, although this is but very rarely necessary. Even in extensive cases the results, after the application of the clamp and cautery to three or four of the largest hemorrhoids, are very satisfactory, the others disappearing shortly after the operation. In case, however, it seems desirable to choose a still more thorough operation the following will bring a satisfactory outcome.

Radical operation. An incision is made at the margin of the anus and the mucous membrane, together with the enlarged hemorrhoidal veins, dissected out carefully for a distance of two to four centimeters. The mucous membrane is then drawn down from above and about eight interrupted catgut stitches are applied at regular intervals, reaching through all the coats of the intestine down to the mucous membrane, but not through it, and through the subcutaneous connective tissue at the margin of the anus. These stitches should be so applied that after the portion of the rectum containing the hemorrhoids has been cut away there will be still a slight projection of the mucous membrane of the rectum beyond the margin of the anus. All bleeding points are caught during the operation and carefully ligated with fine catgut. After the intestine has been sutured in place in this manner the projecting portion is cut away and the mucous membrane of the intestine sutured accurately to the skin, the normal portion projecting a little beyond the margin of the latter. If the eight stay sutures which were first applied are carefully placed their pressure will control the hemorrhage from the hemorrhoidal veins, so there will be no bleeding when the projecting portion is cut away.

The treatment after this operation is the same as after the operations which have been just described.

This last operation is very attractive, but in the vast majority of cases it is unnecessary.

Prognosis. It does not matter which operation is chosen, the prognosis will largely depend upon the hygienic conditions the patient provides for himself. If proper food is taken, if constipation is avoided, and if proper exercise is enjoyed, the patient will remain permanently cured, which is not likely if these conditions are neglected.

FISSURE IN ANO

One of the most painful affections, and which frequently accompanies the presence of hemorrhoids, or is secondary to the latter, is a fissure in ano, which is a small lesion extending parallel with the rectum, and consequently at right angles with the sphincter ani muscles. It is this last fact which causes this condition to resist treatment, as the wound constantly gives rise to spasmodic contractions of the sphincter ani muscles, and these in turn crush the surface which is already sore. The evacuation of the bowels is likely to open the wound, which may have begun to heal during the interval, and the accompanying pain gives rise to spasmodic contraction of the sphincter muscles; consequently the patient suffers severely for some time after the bowels have been evacuated. The application of remedies is of very little benefit, for the reasons just mentioned. Unless the condition is but very slight an operation must usually be resorted to before the patient can be properly and completely relieved.

Technique. The operation in moderate cases consists simply in thoroughly dilating the sphincter ani muscles so that the wound may remain at rest for a

few days. At the end of this time it will have healed spontaneously. If, however, the fissure has existed for a number of months, or years, the amount of cicatricial tissue formed along its course may be considerable, and then the simple operation of stretching the sphincter ani muscles may no longer suffice to give relief. In such cases the muscles should be stretched very thoroughly, and then the cicatricial tissue excised and the mucous membrane brought down from above and attached to the wound at the margin of the anus with a few fine catgut sutures. This simple method has, in our experience, resulted in the relief of even very severe cases which had existed for a long time.

The after-treatment is the same as in operation for hemorrhoids.

FISTULA IN ANO

It is but rarely that one suffering from fistula in ano comes under the care of a surgeon during the early part of his disease. He has usually suffered for months, or years, and has made use of various local remedies without benefit.

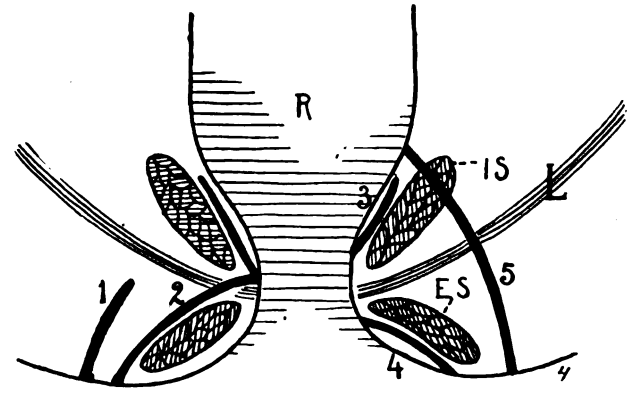
History. The patient gives a history of having suffered from an acute infection in the ischio-rectal fossa, which resulted in an abscess, variable in size, opening spontaneously or by an incision. Before the occurrence of this infection there is generally a history of hemorrhoids. There has usually been a discharge of pus from the opening for a considerable time, during which the patient is fairly free from pain. Then the opening would close and there would be a reaccumulation of pus within the abscess, again provoking much suffering. These events may have existed for a greater or less extent of time, and there may have been a variable number of reaccumulations of pus. There may be one or a number of external openings. Quite a considerable proportion of these cases give a history of cough, and upon examination some evidence of pulmonary tuberculosis may be established.

The usual practice of introducing a probe into one of these fistulæ is, we believe, to be condemned, because it gives rise to an amount of pain, it may produce a new infection, and it does not afford the surgeon any information which he cannot obtain by simply looking at the external surface, and by making a digital examination.

Technique. The treatment should invariably be surgical, although long-continued applications, curettements and irrigations may, in very rare cases, result in a cure of the rectal fistula; still these instances are so uncommon that it is much better to invariably proceed to the radical surgical treatment as soon as the consent of the patient can be obtained.

The preparatory treatment should be the same as that described for hemorrhoid operation. The patient is anesthetized and the sphincter ani muscles dilated. Then a grooved director is inserted into the fistula from without and the finger within the rectum feels for a little projection in the form of a granulation, readily found in quite a large proportion. By carefully manipulating the grooved director it will find its way along the fistula to a point opposite this granulation, through which it can be pushed into the rectum. Then an incision is made directly through all of the tissues between the grooved director and the rectum. Sharp retractors are placed in the edges of the wound and the granulations carefully curetted away. If the sugeon looks for prolongations of the fistula, even these, too, in case they exist, end in a little granulation tissue projecting into the sinus which has been curetted. By looking for this little granulation one can feel all the various sinuses, and by laying them open freely and curetting away the granulation tissue, obtain a perfectly clean wound. If the fistulæ have burrowed through the tissues beyond the sphincter ani muscles in various places the latter should not be severed except at the point of the first incision, for fear of having the patient lose control over the

action of the bowels and the passage of gas. In case the fistula has existed for a long time the cicatricial tissue formed should be dissected away with a sharp scalpel, in order to leave the surface perfectly free and to have all portions of the wound as clean-cut surfaces. If all of the infected tissue has been removed, the course to be followed may consist in tamponing the raw surface with iodoform gauze, to be left in place for a number of days, and then replaced daily after evacuation of the bowels, or the surface may be closed by suturing. The latter method should only be chosen when the surgeon is absolutely certain that all portions of the infected tissue have been thoroughly removed. Then deep, silkworm gut sutures may be inserted so they are buried throughout their entire extent, entering the tissues at a point half an inch from the edge of the original wound, passing entirely around the area of the wound and issuing on the opposite side half an inch from the edge of the original incision. The mucous membrane of the rectum may be sutured separately with a row of catgut sutures, the silkworm sutures remaining untied in the meantime. If the sphincter ani muscles have been cut a few catgut sutures may be passed



1. Blind External Fistula. 2. Complete Fistula. 3. Blind Internal Fistula.

through them and tied separately. Then the deep silk-worm gut sutures are tied over all and a few coaptation stitches applied to the skin. This method will succeed in healing most of the simple fistulæ within ten days or two weeks; at the end of which time the deep silk-worm gut sutures are removed.

After-treatment. The after-treatment is the same as in operation for hemorrhoids. If, however, the wound has not been closed with sutures an enema should be given after each evacuation of the bowels, and then the iodoform gauze tampon again applied to the wound, in order to compel the latter to heal from the bottom.

PROLAPSE OF THE RECTUM

This occurs more frequently in childhood than during any other period. It is usually the result of straining due to constipation, or on account of phimosis in young children, or because of the presence of a fissure, giving rise to tenesmus. The mucous membrane of the rectum usually prolapses during the evacuation of the bowel and it becomes difficult and painful to replace it.

Technique. If one of the causes mentioned still exists, it should be relieved and the condition treated in a non-surgical way at first. The patient should be placed in the inverted position and gentle pressure made upon the prolapsed

portion, and a suppository composed of cocoa butter, some mild antiseptic substance, and some astringent substance, should be inserted into the bowel. The lower end of the child's bed should be elevated so as to add the benefit of gravitation to the treatment. If this form of treatment does not succeed in relieving the child, he should be anesthetized, the sphincter ani muscles very gently dilated, and then the treatment with clamp and cautery described under the head of hemorrhoids employed, with the exception that only a very small depth of tissue should be caught by the clamp, and also that the eschar extend a distance of three or four centimeters along the lower end of the bowel. Three, or at least four, longitudinal eschars will almost always suffice to relieve a prolapse in children. Of course, the same care should be exercised to have the eschars extend parallel with the bowel, in connection with the clamp and cautery operation for hemorrhoids.

In severe forms. In the adult prolapse frequently follows the long-continued existence of hemorrhoids, and usually the relief of the latter will result in the relief of the prolapse. In rare instances it happens, however, that neither of the operations described for the relief of hemorrhoids could promise any relief in this condition because the entire wall of the intestine may have prolapsed through the anus for a distance of a number of inches. In this event the prolapse should be reduced, after the preparations described in connection with hemorrhoid operations have been carried out. The patient should be placed in bed, with the foot of the bed elevated from six to ten inches. This position is kept for a variable period, depending upon the severity of the prolapse—from one or two days to as many weeks—in order to disperse the edema which may exist in the intestine. Then an abdominal section is made through the median line and the lower end of the sigmoid flexure is found and carried to the left side of the abdominal cavity and stitched by means of a considerable number of fine silk sutures directly to the abdominal wall a little in front of its normal location. In this manner the entire rectum and the lower end of the sigmoid flexure will be carried upwards sufficiently to prevent recurrence of the prolapse. The sphincter ani muscles should be very thoroughly stretched so as to prevent any obstruction to the passage of gas and feces until the intestine has become firmly united with the parietal peritoneum.

If the sigmoid is drawn upwards, when the abdomen is opened with the patient lying in the Trendelenburg position, the prolapsing peritoneal pouch can be seen and obliterated with interrupted silk sutures, which will give the rectum a very substantial support.

It is important that a non-absorbable suture be used, because if the intestine is sutured with ordinary catgut the adhesions will be likely to absorb and the patient suffer from a recurrence, while if silk or chromicized catgut is employed this cannot occur. The bowels should be carefully regulated after this operation, so that there never is too great an accumulation in the large intestine.

All other causes of intra-abdominal pressure should also be overcome. If there is an obstruction to the passage of urine due to the presence of a stricture or enlargement of the prostate gland, it should be relieved. If the patient is suffering from a great accumulation of fat in the omentum, mesentery and abdominal walls, it should be relieved by proper diet and exercise. If all of these precautions are carried out a recurrence is not likely.

CARCINOMA OF THE RECTUM

Patients suffering from carcinoma of the rectum usually give a history of long-continued irregularity in the evacuation of the bowels. At first there

is usually long-continued constipation; then this is interrupted by occasional attacks of diarrhea; then a history of the evacuation of ribbon-like formations of feces, indicating some constriction in the rectum, and later on there is usually complete temporary obstruction which may exist for only a short time at first and may recur at various intervals, or the patient may come under the observation of the surgeon during the first one of these attacks of obstruction. In most cases there is a passage of thick mucus, either with the bowel evacuation or during the interval between evacuations. In many there is also a slight amount of hemorrhage, and very rarely one of these patients suffers from a severe hemorrhage from the rectum.

Upon examination a hard, nodular mass is felt in the rectum, usually with a small central opening, or the mass may be upon one side of the rectum and on the other the mucous membrane may be normal. The sensation to the touch of a carcinoma of the rectum is so characteristic that if a surgeon has once experienced it he will have no difficulty thereafter in its recognition. It differs from the feel of a stricture because of the nodular character, and because of the tumor-like projection of the mass, while a cicatricial stricture simply presents the sensation of a narrowing of the canal. It differs from a tubercular stricture from the fact that although the latter also is nodular in character it does not give the impression of a tumor-like projection.

Technique. If the carcinoma is in the lowest portion of the rectum, does not extend above the cul-de-sac of Douglas, and is movable, the treatment should consist in the excision of the entire mass, together with the surrounding tissues to as great an extent as possible. The incision through the skin should be free, should pass up behind to the lower edge of the sacrum, should include the coccyx, and the entire mass should be loosened from its attachment in one piece, so as to avoid the implantation of carcinomatous tissue during the operation. The rectum should be freed for a distance of at least two inches beyond the upper margin of the carcinoma, two pairs of strong forceps should be applied to the bowel at this point, and the latter severed between these forceps and the tumor thus removed. The bleeding vessels should be caught during the operation, so that the loss of blood will be reduced to a minimum, and from time to time all of these vessels thus caught should be ligated so as to leave the field of operation as free from obstruction, on account of the presence of hemostatic forceps, as possible. The upper segment of the intestine should then be freed sufficiently so that it can be brought into the upper angle of the wound and carefully sutured to the skin.

We have never encountered a carcinoma of the rectum in which it seemed safe to preserve the sphincter ani muscles. In a few cases in which we have attempted to remove the malignant growth and to attach the upper segment of the intestine to the lower segment, thus preserving the sphincter ani muscles, there has been a recurrence, but in the vast majority the fact that a recurrence would follow was so plain at the time of the operation that the preservation of the sphincter ani muscles was not undertaken.

If carcinoma of the rectum is so far advanced that a rapid recurrence would be inevitable in case of its excision, which can usually be predicted when the tumor is removed, then we believe it is much wiser simply to do an inguinal colostomy, already described earlier in this section.

If the carcinoma is in the upper portion of the rectum, or in the lower portion of the sigmoid flexure, then one of the operations previously described in this section should be done. In the female it often occurs that the carcinoma is upon the anterior surface of the rectal wall and has attacked the recto-vaginal septum; then the posterior vaginal wall should be removed, together with the entire rectum, after the method above described.

The after-treatment is the same as in operations for hemorrhoids, with

the exception that the wound should be dressed daily in order to prevent its infection.

Prognosis. Where the carcinoma has not perforated any portion of the intestine, the prognosis is relatively good, provided the amount of tissue removed is quite as extensive as though the case were advanced in its development. In advanced cases the prognosis is not good, without regard to the operation chosen. In our experience the cases in which permanent inguinal colostomy was made prior to the excision of the carcinoma have lived longer than those in which the feces were permitted to pass through the rectum after the excision of the growth.

If it seems possible to secure a radical removal of the carcinoma by including a portion of the vaginal wall the following steps should be taken in the operation. Long, narrow retractors are introduced to each side into the vagina in order to expose its posterior wall freely, then an elliptical incision is made to include the entire posterior vaginal wall. The bleeding vessels are carefully caught and ligated and the incision carried backward on each side and around the anus a distance of at least 4 cm. from the anal orifice. The two incisions will meet opposite the tip of the coccyx. From this point a median incision is carried upward to a point 3 cm. above the lower end of the sacrum. At this point the wound is held open by means of retractors and the coccyx separated from its attachment to the sacrum by means of a chisel. This bone is left attached to the rectum, with which it is removed. It is not uncommon to find just in front of the coccyx, or in front of the sacrum, one or more infected lymph glands, and great care should be exercised in removing the tissues at this point. The entire tumor, together with the surrounding tissues, is now dissected out, care being taken to grasp the bleeding vessels as soon as they are severed, especially the branches of the inferior pudic artery and the hemorrhoidal vein, in order to reduce the shock from hemorrhage to a minimum. This leaves the entire mass dissected out and only attached above to the healthy intestine.

The intestine is then at once grasped by two pairs of hemostatic forceps at least 4 cm. above the upper margin of the tumor. By cutting the intestine between these the tumor can be removed without danger of soiling the wound. The upper segment is now carefully loosened so it can be brought down without tension. It is important to clamp the tissues, in doing this, before they are severed, with the hemostatic forceps in order to prevent dangerous hemorrhage. These tissues are carefully ligated after the intestine has been thoroughly loosened. Then the intestine is brought down and sutured to the posterior margin of the incision. It is important to carry the intestine at least 3 cm. beyond the margin of the skin because if this precaution is not taken it is almost certain to retract, and if it retracts within the margin of the skin a stricture is sure to occur. Here, as in all cases in which tubular stricture is brought to the surface, it is best to apply a number of sutures several cm. back from the outer surface for the purpose of attaching the intestine to the wound surface, through which it is carried. Retraction of the intestine is much less likely to occur if this precaution is taken. Aside from this it is well to apply at least four sutures 2 cm. from the margin of the intestine to the skin, and the same number directly between the margin and the skin.

THE COMBINED ABDOMINAL AND PERINEAL METHOD OF REMOVING CARCINOMA OF THE RECTUM

Where the carcinoma of the rectum extends upward too far to be completely removable from below, it is well to begin the operation after the method

just described, loosening the rectum from below together with the tumor, removing the lymph nodes and fat and thoroughly controlling the hemorrhage. Then the entire space should be thoroughly tamponed with gauze and covered with sterile towels.

The patient is then placed in the exaggerated Trendelenburg position and a large median abdominal incision made extending from the pubis to the umbilicus. The sigmoid is brought into the wound and the point determined sufficiently far above the tumor to prevent recurrence. Two clamps are applied at this point and the sigmoid cut between them.

The upper end is covered with gauze and the lower segment carefully dissected out by applying forceps successively to the vessels entering the intestine.

The dissection is carried on until the portions of the sigmoid and rectum have been completely dissected out, when this will be removed together with the tumor. All of the fat and the lymph nodes are then dissected out with gauze dissection, then all of the vessels are ligated, the wound is drained downward with cigarette and gauze drainage and the entire surface covered with peritoneum.

The upper segment of the sigmoid is then passed through the abdominal wall, according to the method described under inguinal colostomy, and the abdominal wall is closed.

If the tumor is fairly circumscribed, the prognosis is good after this operation.

TUMORS OF THE ABDOMINAL WALL

Lipoma. Fatty tumors are occasionally found in the abdominal walls and can be removed without danger by simply making an incision down to the growth, enucleating it, and closing the wound in the skin.

Fibro-sarcoma. Fibro-sarcomata frequently occur in the abdominal walls, taking their origin from any one of the various fasciæ; hence their name, *desmoids*. These tumors usually follow severe straining during labor and most commonly occupy the lower end of the abdominal muscles.

They should be removed freely, a considerable amount of the surrounding tissue being sacrificed. This usually involves one or more of the important muscles of the abdominal wall which must be replaced by a plastic operation consisting in the splitting of other portions of the abdominal wall and overlapping. Fortunately these tumors are relatively not very malignant, and a number have been permanently cured by removal. It is usually well for patients to wear some form of abdominal supporter after recovering from this operation.

ABSCESSES IN THE ABDOMINAL WALL

Abscesses in the abdominal wall sometimes follow traumatism, but more frequently result from an infection within the peritoneal cavity which has perforated a portion of the abdominal wall, from infections of the ribs which have burrowed downward, from empyemata of the chest which have burrowed downward, or from tubercular abscesses of the spine which have followed some portion of the transversalis fascia. The intra-peritoneal origin of these abscesses is most commonly the vermiform appendix, Fallopian tube, gall-bladder, stomach, kidney, or urinary bladder. Foreign bodies, such as needles, nails or sharp bones, may penetrate any portions of the alimentary canal and through adhesions of these to the abdominal wall, penetrate the latter and give rise to abscesses.

Treatment. If the abscess is not tubercular in character it is best to lay it widely open, curette away all granulation tissues carefully, and by looking for small areas in which granulation tissue persists, one can usually follow the abscess to the point from which the infection originated. If this can be done and the cause removed with safety, it is well. If the origin of the infection cannot be found it is best to tampon the abscess cavity widely open and at the future dressing look for the source of infection, which can be determined from the fact that at some point there will be a new accumulation of pus. Often during the original operation the source of infection may be determined by making pressure upon the surrounding portions of the abdominal wall and watching for some point from which pus shows upon such pressure.

Thoroughness in exploration is the foundation of success in operation for the relief of this condition. If it does not seem safe to follow the infection to its point of origin at the first operation, it is often best to tampon the abscess cavity and later approach the condition from the abdominal cavity through a new incision, the location of infection having been determined by the primary operation.

INFECTION OF THE UMBILICUS

Frequently in infants, and occasionally in the adult, infection of the umbilicus occurs, which may result simply in a slight superficial ulcer characterized by a tendency to remain open, or it may be deep-seated forming an abscess of the abdominal wall which may vary in depth, occasionally extending down to the peritoneum.

Treatment. In superficial infections simple disinfection, the application of antiseptic dressings, and keeping the surface clean, will result in healing. In deep-seated infections, it is important to curette away all of the infected tissue down to the deepest portion of the infected part, to disinfect the surface and tampon and permit healing to take place from the bottom. In either case the patient should be kept at rest.

Occasionally such an infection depends upon a remnant of the omphalomesenteric duct which should have been obliterated before the birth of the child. In such cases the mucous membrane lining this embryonic structure must be entirely removed in order to secure a permanent cure, because any remnant will be sure to be the cause of a new abscess as soon as the tissues have healed over this area.

In many of these the duct is continuous with the lumen of the small intestine. Then it is necessary to perform an abdominal section, excise the entire umbilicus, determine its point of attachment to the intestine and treat this attachment precisely after the manner of removing the appendix from the cecum, especial care being taken not to narrow the lumen of the small intestine at the point of removal of this remnant of the duct.

PART VI

SURGERY OF THE ESOPHAGUS AND STOMACH

SURGERY OF THE ESOPHAGUS

Surgery of the esophagus in comparison with surgery of the rest of the gastro-intestinal tract is limited and probably will always remain so on account of the nature and position of the part.

In many conditions the treatment is of a palliative character. The distress from interference with the function of the esophagus is so great that these palliative measures seem worth while.

Methods of examination. The most common method is the passing of bougies. In sounding the esophagus it is important to remember that under normal conditions the canal possesses four constrictions. It is also important to know the total length of the tract and the distance of its most important portion from the teeth. The esophagus is ten inches in length. It begins six inches from the incisor teeth and passes through the diaphragm sixteen inches from the teeth. It is crossed by the arch of the aorta ten inches from the teeth.

The examination with a bougie should be conducted very carefully and slowly, for in this way only is it possible to follow the course of the tube without injury, especially when it is in a diseased condition.

Two kinds of bougies may be used for sounding the esophagus, the English bougies or the olive-tipped bougies. The former are constructed of a woven material, impregnated with a gummy substance, and may be softened or hardened by placing them in warm or cold water, respectively. In this manner they may be bent into any desired shape. The olive-pointed bougies consist of a flexible hard rubber staff, on the point of which is placed an olive-shaped tip of hard rubber or ivory.

When a stricture is present it is easier to determine its location by means of the olive-tipped than by the English bougie.

Before sounding an esophagus, artificial teeth should be removed and the patient examined for aneurism of the aorta. The passing of bougies in cases of aortic aneurism has been known to cause death from hemorrhage.

Patients who are being examined for the first time are apt to gag, making the procedure very unpleasant. This may be overcome to a great extent by first spraying the pharynx with a four per cent. solution of cocaine, allowing the patient to swallow a little of same, then waiting five minutes before passing the sounds. The bougies are passed with the patient in a sitting posture, with the head erect or bent a little forward; then the operator places the index finger of his left hand on the base of the tongue, pressing downward and forward, while the bougie is passed by the right hand along the posterior wall of the pharynx to the beginning of the esophagus. The patient is now told to swallow and the sound will pass on into the esophagus.

A half-inch bougie should easily pass through every portion of the esophagus. Its failure so to pass is a sign of stricture. A three-fourths-inch bougie is as large as should ever be used in dilating a stricture.

Occasionally in passing the bougie one meets with an apparent obstruction. In these cases it is sufficient under normal conditions to withdraw the bougie a short distance and then advance it again, or the obstruction may be overcome by asking the patient to swallow or to bend the head a little forward.

Esophagoscopy. Esophagoscopy cannot be considered an important aid in diagnosis. Little is to be determined by this means that cannot be ascertained by the more simple methods of examination. The simplest and safest form of esophagoscopy is by the straight tube, the light being thrown into this by either a Leiter panelectroscope or a Casper electroscope. Numerous devices for esophagoscopy have been invented during the past few years, but not much evidence of value has accumulated from their use. Esophagoscopy should only be attempted by those who have had special training along this line of work.

Radioscopy. Radioscopy is frequently a valuable aid in the diagnosis of esophageal lesions, especially in the location of foreign bodies. It may also be considered in connection with the diagnosis of strictures, dilatation and diverticula.

A rather definite outline of the esophagus may be obtained by an X-ray photograph by administering a large quantity of bismuth, mixed with some starchy food, just before the picture is taken.

Percussion. Percussion is of minor importance in the diagnosis of lesions of the esophagus. In diverticulum in the neck, if the latter is filled with gas, percussion will give a tympanitic note; if filled with food, a dull note. Occasionally in the presence of a growth in the esophagus one is able to determine a dull area corresponding to the location of the tumor.

INFLAMMATORY PROCESSES OF THE ESOPHAGUS

Acute catarrhal inflammation of the esophagus may result from the irritation caused by foreign bodies, from a mild scalding, or from swallowing some chemical causing an irritation but not strong enough to cauterize. It is characterized by the secretion of mucoid material. Where the inflammation is more severe, it may result in superficial erosion or ulcers, but these usually heal without any serious consequences.

Chronic catarrhal inflammation of the esophagus occurs in chronic alcoholics, also in cases of stenosis of the esophagus from various causes, and from the accumulation of food in a dilated portion above a stricture. These cases usually recover without any complications by relieving the cause of the inflammation.

TOXIC ESOPHAGITIS

Toxic or corrosive esophagitis occurs after the ingestion of some chemical caustic substance, or a scalding fluid may act in the same manner. From a surgical standpoint toxic esophagitis is the most important inflammation of the esophagus, because of the complications which are apt to follow, especially the formation of strictures. In cases where the injury is only superficial, the epithelial layer may be thrown off without any complications following. Where the erosion is deep, causing a slough of the entire thickness of the mucosa. and perhaps some of the muscular coat, the inflammation may extend beyond the esophagus, forming a peri-esophageal abscess extending into the mediastinum. The eroded area undergoes cicatrization after the slough is thrown off and as a result of the contraction of this scar a stricture is apt to follow. Swallowing of a large amount of the concentrated alkalies or acids is apt to end fatally on account of the slough it usually causes in the stomach.

The authors recently had a case of a woman who tried to commit suicide by swallowing one ounce of strong hydrochloric acid. The patient was remarkably free from esophageal symptoms, but nine days after the ingestion of the acid she vomited a large roll of tissue, which proved to be a considerable portion of the mucous lining of the stomach. The tissue was in one piece, was somewhat gangrenous in appearance and measured fifty square inches. The patient was kept on liquid food and had no symptom referable to the esophagus, but complained some of a burning pain in the stomach. After about four weeks she began to lose in weight rapidly and every second or third day would vomit a large amount of dark fluid. We first saw the patient twelve weeks after the swallowing of the acid. At this time she complained of a large swelling in the abdomen, which she said seemed like a large sac of water. The patient was greatly emaciated and on examination there was a soft mass extending from the epigastrium to the symphysis pubis. A distinct splashing sound could be elicited and a peristaltic wave seen beginning in the left inguinal region and extending to the region of the pylorus. A stomach tube was inserted which passed easily, and five quarts of a dark brownish fluid was withdrawn. The patient was placed on rectal feeding and gastric lavage was used three times daily for three days. At this time a laparotomy was performed. The stomach had contracted to the level of the umbilicus and there was a cicatricial mass in the pyloric end, causing practically a complete obstruction of the pylorus. A gastroenterostomy was performed. The patient did very well for nine days, when she died suddenly from pulmonary embolism. Examination of the esophagus at the post-mortem showed no evidence of injury from the swallowing of the acid.

Treatment. The treatment of corrosive esophagitis is principally symptomatic at first. Rectal feeding, ice, narcotics. Examination with bougies should not be undertaken as long as there is any evidence of recent ulceration. Such ulcerations usually continue from two to four weeks, according to the degree of the burn. After four weeks bougies may be passed as a prophylactic measure against the formation of strictures.

PHLEGMON OF THE ESOPHAGUS

Phlegmonous inflammation of the esophagus is of rare occurrence. This purulent inflammation may occur after penetrating injuries, and injuries caused by caustics or from extension from abscess of the stomach, and by rupture of a peri-esophageal abscess. The inflammation may be circumscribed or diffuse, extending over large areas. Abscesses may form with bulging of the mucous membrane of the esophagus, causing an obstruction. These abscesses usually rupture spontaneously into the esophagus. The symptoms in these cases vary; fever, chills, difficulty in swallowing, pain along the course of the esophagus, especially behind the sternum. There may be coughing and regurgitation of pus if there is abscess formation. The treatment is ordinarily symptomatic, but some authors suggest esophagoscopy and incision in case of abscess formation.

ULCER OF THE ESOPHAGUS

Various forms of ulceration are met with in the esophagus: gangrenous ulcers from pressure, syphilitic, tubercular and the peptic or round ulcers. Gangrenous ulcers may be caused by pressure from within or from without. Goitre or some other tumor may make pressure upon the cricoid or one of the tracheal rings, causing pressure on the esophagus, resulting in a necrosis of one or both of the walls. Aneurysm of the aorta may act in the same manner, also foreign bodies from within.

Syphilitic ulcers may occur in the esophagus, but are very rare. They usually are situated in the upper portion of the tube. The lesion is usually a gumma, and frequently results in scar formation, causing constriction. In many cases the diagnosis is made by noticing the effect of anti-syphilitic treatment.

The occurrence of tuberculous ulcers has recently been positively determined, but they are very rare.

Peptic or round ulcers, analogous to those found in the stomach, occasionally are found in the esophagus. They are frequently associated with ulcers of the stomach and are situated in the lower portion of the esophagus. They may or may not cause symptoms, but when present they are similar to those of gastric ulcer.

NEW GROWTHS OF THE ESOPHAGUS

Carcinoma is the most frequent of the new growths of the esophagus, in fact it is the most common disease met with in the esophagus. It may occur either primary or secondary. When secondary it usually occurs by direct extension from neighboring organs. It may occur through inoculation from the secretion of a carcinomatous ulcer higher up in the gastro-intestinal tract.

Carcinoma of the esophagus is most common in the male and, the same as other carcinomas, is usually a disease of advanced life.

It is usually situated at one of the normal constrictions of the esophagus corresponding to the cricoid cartilage, the bifurcation of the trachea and the hiatus of the esophagus. This fact rather favors the view that there may be some connection between repeated irritations and the development of carcinoma, as these portions of the esophagus are constantly subjected to irritation more than the rest of the canal.

Strictures are also most common at these points, so it is possible that carcinoma develops in a cicatricial stricture or some other scar.

It is estimated that about fifty per cent. of the cases of esophageal carcinoma occur at the cardia, or just above where the esophagus passes through the diaphragm. About forty per cent. are found near the bifurcation of the trachea, and less than ten per cent. in the cervical portion of the esophagus.

Symptoms. The most important and usually the earliest symptom of carcinoma of the esophagus is dysphagia. The manifestations are those of a slowly-advancing stenosis. The patient usually comes giving a history of having been in good health until a few months before, when he began to have some difficulty in swallowing meat or other coarse food. This condition gradually becomes worse, when the patient has difficulty in swallowing soft foods, and finally confines himself solely to liquid food. Usually by the time the patient consults a surgeon he has lived on liquids for a considerable period on account of the difficulty of swallowing solids. Coincidentally with the difficulty of swallowing, there is usually a sense of weakness and a progressive loss of weight.

Considerable improvement may be noted upon the administration of non-irritating liquid foods. A gain of several pounds is possible for a short time by giving an abundance of milk, cream and raw eggs. There is seldom any vomiting, but usually a regurgitation of food and large quantities of mucus. This regurgitation may take place very quietly and is entirely different from vomiting. In the later stages the accumulation of thick, tenacious mucus above the stenosis may cause gagging and retching, which is very annoying.

It is not uncommon to have some hoarseness rather early, gradually becoming more pronounced on account of the further involvement of the recurrent laryngeal nerve.

As a rule there is more or less pain associated with carcinoma of the esophagus. This is described as a sense of burning or pressure in the throat or chest, especially during swallowing. Occasionally the pain precedes the dysphagia. It is frequently felt in the back, radiating to the shoulders and the back of the neck. The loss of weight and strength in these cases is at first due to the dysphagia, and later they result also from the malignant

ELASTIC DILATING BOUGIE ESPECIALLY DESIGNED FOR ESOPHAGEAL STRICTURE.

1, Graduated flexible bougie hollow, made of spiral steel; 2, Lead rod to be placed in lumen of 1 enabling the operator to give the bougie definite curves; 3, Short; 4, Long, filiform bougie to be screwed into the distal end of 1.

pathological process. In advanced instances it is not uncommon to have a contracted pupil on one side. According to Hitzig this is found in about one-sixth of the cases. The left pupil is most frequently involved. It is due to pressure upon the sympathetic nerve.

While an involvement of the recurrent nerves may occasionally be found as an early symptom, it most often means that the disease has made considerable progress. The pressure may be due to the growth itself, but is probably most often due to an involvement of the lymphatic glands.

Besides hoarseness, this pressure may cause attacks of dyspnea.

Diagnosis. By taking a careful history one can usually obtain many important diagnostic points.

In a patient with slowly-progressing stenosis, and the absence of any traumatic, specific or other etiological factor, the obstruction is more apt to be due to new growth than to a cicatricial stenosis. Then if the patient be past forty years of age, is a male and the above-mentioned symptoms are present, with emaciation and cachexia, the diagnosis of carcinoma is fairly certain.

On palpation there is occasionally a tumor or induration felt in the neck. This may be the primary growth, but most often it is metastases of the lymphatic glands. Examination with bougies may further aid in the diagnosis by determining the existence of an obstruction and its location. This examination may prove negative even though a carcinoma be present. The growth may be so small that the bougie may glide past without offering a definite resistance. A negative examination may also be due to the fact that necrosis has taken place, and the position of the growth projecting into the lumen of the esophagus may grow only in the long axis of the tube, so that it causes no marked obstruction. When ulceration has taken place more can often be determined by passing a stomach tube or hollow bougie, as particles of tissue may become caught in the fenestrum of the tube and the diagnosis positively determined by the examination of such fragments.

It is often difficult to differentiate between carcinoma of the esophagus and aneurysm of the aorta.

If one will bear in mind the arrangement of the lymphatic glands of the mediastinum, he can readily perceive how two conditions so diverse as an aneurysm of the aorta and carcinoma of the esophagus may cause almost identical symptoms.

The lymphatic glands are in actual contact with the esophagus, so that often secondary involvement occurs very early. This being the case, we have a tumor growth in the mediastinum which may cause the ordinary signs and symptoms produced by aneurysm in the same location. The glands may enlarge so much more rapidly than the primary tumor that there may be symptoms of intra-thoracic pressure before there are any signs of obstruction of the esophagus. In such a case as this, the symptoms would naturally be the same in both conditions, being due to pressure on the same structures.

Dyspnea, which is a fairly constant sign in case of aneurysm of the aorta, is almost as constant a sign in carcinoma of the esophagus. In both the aneurysm and the mediastinal metastasis from the esophageal cancer the dyspnea is due to pressure on the bronchi or trachea. Dysphagia very naturally causes the surgeon to think that he is dealing with a growth of the esophagus, but in many cases of aneurysm of the aorta the esophagus is affected sufficiently to cause dysphagia. Even though the aneurysm does not press directly on the esophagus, it may cause dysphagia by pressure on the vagus, or its esophageal branches.

Thus we see that it is often difficult to differentiate between carcinoma of the esophagus and aneurysm of the aorta, when the growth is situated

in the thoracic portion of the esophagus, especially if there is an early involvement of the mediastinal glands.

Prognosis. The prognosis of carcinoma of the esophagus is always unfavorable. So far as known no permanent cures have been effected even after resection. The average duration of the disease is from six months to two years. The majority of the cases usually succumb one year after the manifestations of the disease.

Death usually takes place slowly from inanition and carcinomatous cachexia, or there may be the typical picture of pyemia. Where there is a perforation and rupture into the air passages, death takes place from pneumonia or gangrene of the lung. Occasionally these patients meet with a rapid and sudden death from erosion and rupture into the large blood vessels.

Treatment. The treatment comprises the following non-operative procedures, viz., dilatation with bougies and dilation by permanent tubage. The operative methods are resection of the esophagus; esophagostomy and gastrostomy.

Dilatation. Dilatation with bougies is quite generally employed, especially by the general practitioner. This is usually successful for a time, as the soft carcinomatous tissue yields readily. This form of treatment is often unavoidable as the patient will not consent to the operative procedures. It should be borne in mind that the bougies cause mechanical irritation, and that the growth may be excited by their use. Great care should be exercised in the use of the bougies on account of danger of perforating into the neighboring organs during the procedure.

The conical-shaped English bougies are the best for this purpose, as they are soft and pliable. The bougies are introduced as described above. Occasionally the carcinomatous stricture will be so small that it will be impossible to pass the bougie through it. Then a filiform bougie may be passed, to the end of which is attached a conical spiral bougie shown in the plate. When this is withdrawn a small-sized English bougie is passed, followed by the larger sizes. Some temporary relief is afforded in this manner.

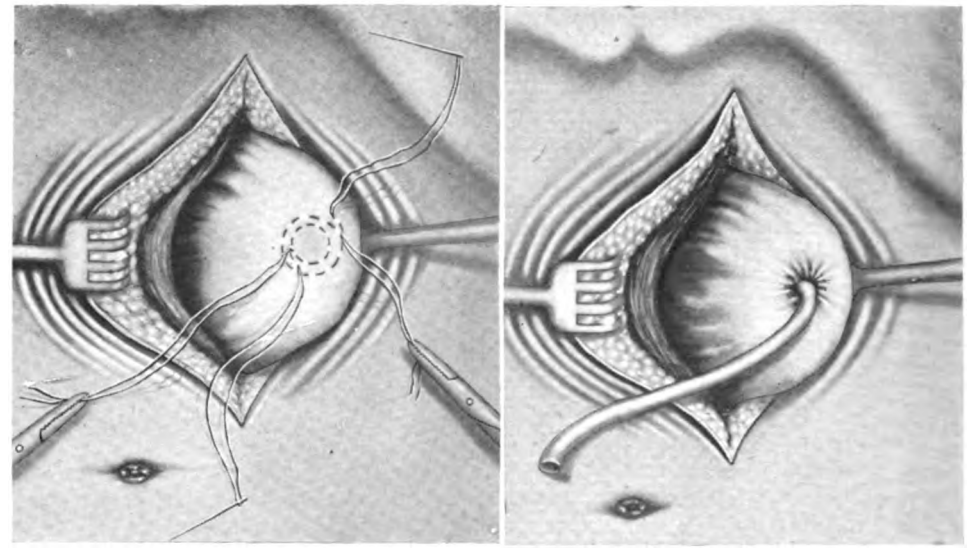
Permanent dilation by introducing a hard rubber tube into the stricture is seldom used. Unpleasant accidents may occur, such as breaking or swallowing the string, and the constant presence of the string in the mouth is very annoying to the patient.

Resection of the esophagus. The majority of cases of carcinoma of the esophagus are not accessible to radical treatment. The authors have had no personal experience in resection of the esophagus for carcinoma. In the few cases recorded in the literature of the subject the immediate mortality is high and the relief in the other cases was only transitory.

It is quite probable that with further development of Sauerbruck's method of operating within a pneumatic cabinet under negative pressure, a satisfactory operation for resection of the esophagus in cases of carcinoma may be made possible.

Esophagostomy. Esophagostomy is occasionally performed and the patient fed through this fistulous opening. This operation is applicable only in cases of carcinoma situated high up in the cervical portion where the opening can be made below the stricture. It is doubtful whether feeding through an esophageal fistula is less annoying to the patient than through a gastrostomy opening; the detail of the latter proceeding being much easier for the patient to carry out himself. As a rule a gastrostomy is preferable to an esophagostomy as a means of these patients taking nourishment.

The technique of esophagostomy is described under the subject of foreign bodies in the esophagus.

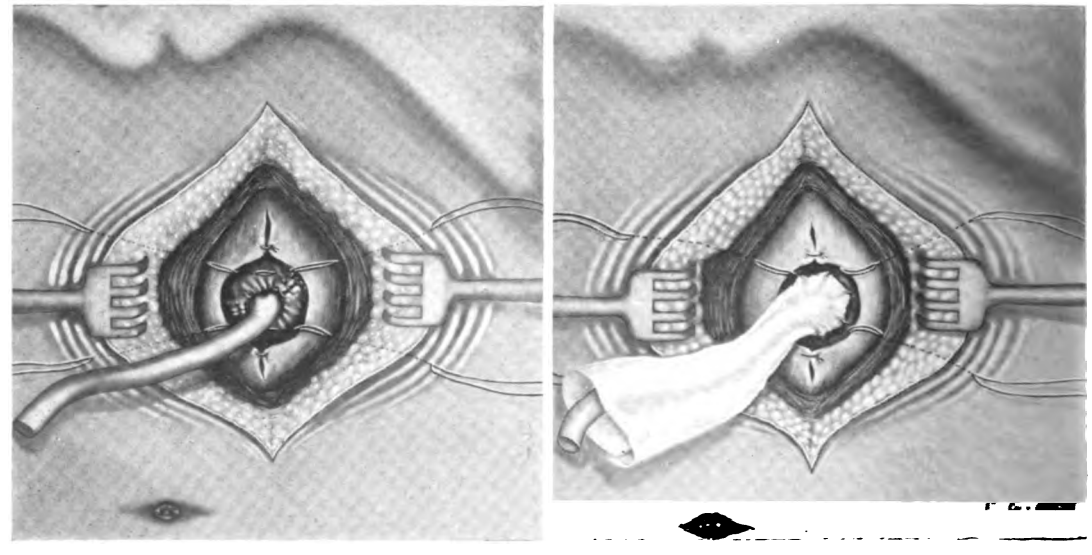


A B

GASTROSTOMY.

A represents the stomach wall drawn out through the abdominal incision, with two circular purse-string sutures in position.

B is the same as plate A, with retention catheter introduced through an opening which has been made in the center of the circle formed by the purse-string sutures. The portion contained within this circle has been inverted into the cavity of the stomach and the sutures have been tied and cut short.



C D

C represents the manner of attaching the stomach to the abdominal wall by means of cat-gut sutures, uniting the stomach to the parietal peritoneum and transversalis fascia. Two deep silkworm gut sutures, which extend through the entire abdominal wall, grasp the wall of the stomach in order to act as stay sutures.

D is the same as plate C with the addition of a piece of iodoform gauze folded about the retention catheter and attached to the wall of the stomach by interrupted cat-gut sutures, in order to make the adhesion to the abdominal wall more secure.

Gastrostomy is indicated where the patient cannot take enough food by mouth, as is shown by rapid emaciation. The earlier the operation is performed, the more satisfactory will be the result. If a positive diagnosis of carcinoma is made, a gastrostomy should be done, even though the patient can still swallow liquids. Of course a gastrostomy cannot stop the progress of the disease, but it may inhibit ichorous decomposition, which is caused by food remaining in the ulcerated area. As a result of the operation the carcinoma may grow less rapidly, because the continuous irritation from the passage of food has been relieved. Oftentimes both physicians and surgeons decide upon an operation too late. This accounts for the fact that the mortality is rather high in this operation. If gastrostomy is performed at the proper time, the life of the patient may be prolonged for several months, or even more than a year.

In choosing the operation it is necessary to select a method which may be rapidly carried out and at the same time effect a closure of the fistula.

Preparatory treatment. If the obstruction is complete the operation should be done at once after securing an evacuation of the bowels by means of a large enema. So long as there is still a slight passage in the obstruction it is well to administer some saline mineral water freely every morning for several days, in order to secure a free evacuation of the bowels, because one frequently finds large accumulations in the colon in these cases, as they have usually been constipated for a long time, and they will bear an operation much better if there is no decomposing substance in any part of the intestinal canal.

If the patient is very weak it is frequently possible to increase his strength considerably by giving some of the various concentrated predigested foods in considerable quantities at regular intervals of two or three hours for a few days. Ordinarily, however, they bear the operation well if performed rapidly and with a minimum amount of traumatism, so that it is only necessary to give the above preparatory treatment to patients who have had little or no care previous to their admission to the hospital.

The field of operation is prepared as in every abdominal operation.

Technique. The incision is made through the outer edge of the left rectus abdominis muscle from one-half to three inches in length. The length of the incision will depend upon the extent of the contraction of the stomach and the thickness of the stomach wall. In case of a contracted stomach with a thick wall, it is necessary to make the incision longer than where there is a large, thin-walled stomach, so as to secure a sufficient amount of space to conduct the necessary manipulations without causing too much traumatism. As soon as the abdomen has been opened a portion of the anterior wall of the stomach is drawn into the wound and two purse-string stitches of fine silk or linen are applied, as shown in the plate; the circle described by the first stitch being about three-fourths of an inch in diameter. In each case a little more than a full circle is described, in order to provide against a possible defect. These stitches grasp all of the layers of the stomach down to the mucous membrane, including the submucous connective tissue. The space within the inner circle is now punctured with a trocar, and a tube from one-quarter to one-half an inch in diameter made out of rather stiff, pure rubber, fashioned after the pattern of a Jacob's retention catheter, is inserted into this opening. This will produce an infolding of the stomach wall, which is still further exaggerated when the purse-string sutures are tied.

The enlargement at the end of the tube prevents its slipping out of the opening, and the close application of the serous surface to the tube prevents any leakage. This condition is still further enforced by the application of several rows of Lembert sutures to each side of the tube, as shown in accompanying plate.

In a thin-walled stomach it may be desirable to apply four or five rows of these interrupted sutures, while in a thick-walled stomach two or three rows outside of the purse-string sutures will suffice. The end of the tube in the stomach should be closed with a cork or clamped with a convenient contrivance, so that no stomach contents may be expelled during the course of the operation. The important condition to be obtained is a provision against leakage, which the above-described method has always accomplished in a most satisfactory manner.

The next step is the attachment of the stomach to the abdominal wall. This is accomplished by first inserting silk-worm gut sutures through all the layers of the abdominal wall, then all the layers of the stomach wall down to the mucous membrane, then out through all of the layers of the abdominal wall on the opposite side. Then the stomach wall is sutured to the peritoneum and transversalis fascia by a number of interrupted sutures. The abdominal wound is then closed in the usual manner by suturing each layer separately, the feeding tube being permitted to pass out through the middle of the wound. A dry, sterile gauze dressing is applied, the tube being permitted to pass out through the center of the dressing and the binder holding the dressing in place, so that the patient may be fed without disturbing the dressing.

In some of these patients who have become much reduced in strength, the adhesions formed between the stomach and the abdominal wall are very frail unless increased by means of some irritation. For this purpose the use of iodoform gauze has proven very satisfactory, it being applied in the following manner: A piece of iodoform gauze is folded around the feeding tube and stitched to the stomach by a number of interrupted catgut sutures. All of the other steps of the operation are carried out as above, this simply being an additional safeguard. After about ten days the catgut sutures will be absorbed and the gauze may be withdrawn. It will usually be found quite adherent and the adhesions between the stomach and the abdominal wall will have become exceedingly firm by this time.

After-treatment. If the obstruction has been complete or nearly so, and the patient suffered severely from thirst before the operation, half a pint of warm, normal salt solution should be poured into the stomach through the feeding tube at the close of the operation, and this should be repeated every half hour until the patient is satisfied. If he had been able to swallow before the operation, he may be allowed to drink water naturally after the procedure if this causes no distress or annoyance; otherwise it is to be given through the feeding tube entirely. After a time the absence of irritation may cause a disappearance of the complete obstruction and then the patient will again be able to take liquids by mouth. In the meantime he should be fed regularly every three hours with peptonized milk, raw egg, the juice extracted from roast beef or broiled steak, rich broths, soups and mush. The food may be poured into the stomach through a funnel, or an ordinary glass syringe may be attached to the feeding tube and this will serve as a funnel.

Later the patient may chew any kind of food very fine, and thus mix it with saliva. He can then inject this through the feeding tube into the stomach. These patients can thus improve their digestion, especially of starchy food, and may continue enjoying their meals in this way.

Almost invariably these patients gain rapidly in weight and strength, because the enforced rest of the stomach and intestines has usually placed these organs in a condition in which they can thoroughly digest an abundance of food. We have repeatedly observed these sufferers gain sufficiently in strength in a few weeks to enable them to do hard labor, which was continued until the carcinoma had implicated some other important organ, either by invasion or by the formation of metastasis.

It is, of course, necessary to explain to the friends of the patient that this operation cannot result in a cure of the disease, but that it can simply give temporary relief. This relief, however, is so great, and the risk in obtaining it is so slight, that it is an operation which may be very strongly recommended. Aside from the distress due to hunger, and especially to thirst, patients afflicted with obstruction of the esophagus suffer pain but slightly, consequently the relief given by this operation is relatively very complete.

CYSTS, PAPILLOMATA, MYOMATA AND SARCOMATA OF THE ESOPHAGUS

Many of the growths occurring in the esophagus, such as warts, cysts, papillomata, fibromata, lipomata, possess only a pathological interest, as they rarely cause disturbance.

Klebs has pointed out the analogy between diseases of the esophagus and those of the skin. Thus in the esophagus are found warts which are usually small and spread over different portions of the tract. It would seem probable that these warts might develop into carcinoma as is seen in skin warts, but so far such an event has never been demonstrated.

Retention cysts of the mucous glands have also been described. On account of their small size they usually do not cause any symptoms.

Fibromata and lipomata also occur, but are very rare. They are usually autopsy findings, as they run their course without producing symptoms.

Sarcomata of the esophagus are rather rare and the symptoms and course of the disease are similar to those of carcinoma. A positive diagnosis can only be made by securing a portion of the tissue for microscopical examination. The treatment is the same as described for carcinoma.

Pedunculated tumors of the esophagus are classified as polypi. They are rather rare. They are usually attached to the upper end of the esophagus in the region of the cricoid cartilage. Small polypi cause no symptoms. The larger ones may cause difficulty in swallowing and occasionally the distal end of the polypus is thrown upwards into the throat, causing choking and difficulty in breathing.

INJURIES OF THE ESOPHAGUS

Trauma from an internal source. The injuries of the esophagus produced by violence from within are those resulting from swallowing various corrosive drugs, from foreign bodies that have been swallowed, also by passing bougies, coin-catchers and other instruments. Injuries from the passing of instruments are particularly liable to occur in the presence of pathological changes such as carcinoma, ulcer, stricture, etc. Perforation of the esophagus is a serious condition, as it may result in a fatal mediastinitis or pleuritis.

Primary traumatism. Primary traumatic injury of the esophagus due to the swallowing of hard substances such as sharp bones from fishes or bone splinters is not very common because the mucous membrane of this organ seems to be capable of enduring ordinary insults.

Secondary injury of the esophagus, from ulceration of the mucous membrane due to the fact that some hard object which has been swallowed and become lodged, is not so rare. In children these objects are most commonly playthings, buttons or coins; in adults they are more commonly bones or artificial teeth.

Dangerous ulceration is more common if the object is lodged at a point where it is subjected to the impulse of the pulsations of the aorta, exposing the patient to the risk of fatal hemorrhage. From this it is clear that it is import-

ant in case a hard object has become lodged in the esophagus to locate it by the use of the X-ray and to take the necessary steps for immediate removal.

EXTERNAL INJURIES OF THE ESOPHAGUS

The esophagus being so deeply situated injuries from violence from without are extremely rare. Wounds of the cervical portion are the most common and usually occur as a result of attempted suicide.

These wounds are usually high up on the neck in the region of the larynx or hyoid bone, so that the wound of the alimentary canal is either high up in the esophagus or in the pharynx. In these cases the respiratory passages are practically always injured at the same time.

Injury of the esophagus alone in the thoracic portion is extremely rare. This may result from daggers, bayonets or bullets. Injuries of adjacent organs, as heart, lungs, large vessels, etc., which are usually fatal in themselves on account of their character and anatomical position, are apt to occur at the same time. The danger from injury to the esophagus is in itself very critical on account of the escape of food into the surrounding tissues, resulting in ichorous abscesses, mediastinitis or pleuritis.

Treatment. When the injury is in the cervical portion, the first thing is to control the hemorrhage and to avoid asphyxia. It frequently is necessary to perform a tracheotomy. If the condition is such as to warrant an operation an attempt should be made to suture the esophagus, also the trachea if that has been severed. The best method is that employed in suturing the intestines, first suturing the mucous membrane and then the muscular coat over this.

Should the injury be in the thoracic portion the treatment is practically hopeless, being usually limited to feeding the patient per rectum or through a stomach tube, if this can be passed down through the injured portion. If the patient is able to stand an operation a gastrostomy will be the best method of feeding.

FOREIGN BODIES IN THE ESOPHAGUS

The lodgment of foreign bodies in the esophagus is not an uncommon condition and is classed as one of the emergencies in the practice of surgery, as they frequently require prompt action on the part of the surgeon. The accident is most often seen in the very young and the insane. The foreign bodies most often found are coins, buttons, pins, keys, glass beads, bones and various kinds of small toys. Foreign bodies are frequently found in food, such as fish-bones, fruit-stones, pieces of glass and enamel. In adults the most frequent foreign body found in the esophagus is a poorly-fitted dental plate which had not been removed at night or which had been swallowed during an attack of syncope or convulsions.

From what has been said one can see what a great variety of foreign bodies may enter into consideration. The situations at which foreign bodies may become lodged depends considerably upon the nature and size of the object. Small pointed bodies which penetrate the mucous membrane easily may lodge at any point along the esophagus. Very large bodies as a rule cannot pass the isthmus and remain lodged in the pharynx. Small, sharp-pointed bodies, like fish-bones and wooden splinters which project from a morsel of food, are apt to be driven into the wall of the pharynx during the first act of swallowing. Large bodies which pass the isthmus may become impacted at the upper border of the cricoid cartilage, where the esophagus

is crossed by the left bronchus, or where the esophagus passes through the diaphragm.

Symptoms. The symptoms vary according to the situation of the object, according to its size and shape and the amount of obstruction present and also to the amount of pressure exerted upon other organs, as the trachea or larynx. There is usually nausea, a sense of obstruction and pain on attempting to swallow and occasionally a reflex cough. If the body is large and remains in the pharynx it may press upon the opening in the larynx and cause choking, accompanied by cyanosis, etc.

If there is complete obstruction all food will be regurgitated. When the obstruction is high up in the esophagus the regurgitation will take place immediately on attempting to swallow, if it is low down a little time may intervene before the food is regurgitated.

In cases in which the foreign body has sharp edges which cause injury the patient complains of a stabbing pain at a definite point on attempting to swallow. This point is apt to be the location of the obstruction when the foreign body is situated high up.

When the impaction is lower down the pain is usually referred to the region of the sternum, though the obstruction may be at a lower level.

Diagnosis. Occasionally a positive diagnosis of an impacted foreign body can be made from the history and symptoms. On account of the serious complications that may arise from a foreign body remaining in the esophagus a long time, an attempt should be made even in doubtful cases to determine the presence or absence of such a substance.

The pharynx should be inspected by means of a mirror, and palpation made with the finger. External palpation should be made, as large bodies in the cervical portion can often be felt, or there may be a point of tenderness corresponding to the location of the object.

In most cases a foreign body can be found by passing a bougie, also its situation determined in this manner. The best bougie for this purpose is a whale-bone staff with a cylindrical tip of ivory or metal. On touching a foreign body with such an instrument a clicking or rubbing sound can be heard or at least felt.

Examination with the X-ray, either by means of the fluoroscope or X-ray photograph, is an important aid in diagnosis and has proved to be very practicable in many instances.

The esophagoscope may be used in these cases both as a means of diagnosis and treatment.

The early use of the esophagoscope for the removal of a foreign body must be strongly urged. During the first day or two after a foreign body is lodged there is very little inflammation present, but after three to four days or a week inflammation becomes intense, abscess formation occurs, perforation of the wall of the esophagus is apt to take place, and above all, after a short time the inflammation surrounding the foreign body makes it difficult to extract. So whenever a foreign body is lodged in the esophagus in an inaccessible position, and when it cannot be pushed down or brought up, the esophagoscope should be used at once, and in a great many cases the foreign body can thus be extracted.

Treatment. The treatment of foreign bodies should be instituted as soon as the diagnosis has been made. The various methods in which no cutting operation is concerned should be tried first, namely, extraction through the mouth, forcing the foreign body down into the stomach, extraction with the aid of the esophagoscope.

Extraction by the aid of the esophagoscope. After an examination of the esophagus has been made with a bougie and the location of the foreign body

has been determined, esophagoscopy should be undertaken with the intention of extracting the foreign body through the mouth, or pushing it into the stomach.

In many cases a foreign body may be removed by aid of the esophagoscope, thus avoiding an esophagotomy or possibly a gastrostomy.

Esophagostomy should only be attempted by those who have had special training and have mastered the technique.

Pushing the object down into the stomach. A foreign body should not be pushed down into the stomach, unless one is fairly certain that the procedure will not be a disadvantage to the patient. The cases in which this method is justifiable are those in which the foreign body is smooth and is not too large to pass the pylorus, and where it cannot be easily grasped with extraction forceps. Also in cases of a soft body, as pieces of meat, potato, etc. The best instrument for this purpose is the ordinary bougie with a cylindrical tip. In case a foreign body passes into the stomach, or is pushed down into the stomach, its passage will be facilitated by feeding the patient mashed potatoes for a few days.

Where the above methods are unsuccessful, or in cases where they are contraindicated, a surgical operation should be performed. Even though the foreign body is such that it will not likely pass the pylorus safely, it is justifiable to push it down into the stomach and perform a gastrotomy later, for the latter operation is much simpler and less dangerous than any external procedure for impaction in the esophagus.

There are two methods of approach, one by an external esophagotomy and the other by a gastrotomy. The selection of the method must depend upon the location of the impaction.

As a rule if it is at the cricoid cartilage or any place above the suprasternal notch, an esophagotomy should be performed; if below the sternal notch a gastrotomy.

Esophagotomy. The patient is anesthetized and placed with the shoulders well raised and a sand bag under the neck so as to throw the head somewhat backwards. An incision is made on the left side of the neck corresponding with the anterior border of the sterno-mastoid muscle. It is carried directly down to the muscle. Blunt dissection is now used until the anterior belly of the myo-hyoid muscle is reached. This muscle and the sterno-thyroid and sterno-hyoid muscles are retracted inwards. The lateral wall of the trachea can now be felt and on stretching the wound open the esophagus should be seen immediately behind the trachea. Great assistance in locating the esophagus can be rendered by placing a bougie with a large bulb in the canal and pressing toward the wound. The esophagus is now separated from its connections both anteriorly and posteriorly by means of blunt dissection, so that it is possible to bring the esophagus up near the edges of the skin wound. The remainder of the wound is now packed off with small pads so as to prevent any discharge which might come from the esophagus from infecting the wound.

An incision is now made upon the bulb and the cut edges of the esophagus grasped by means of two mouse-toothed forceps. The esophagus is now explored by means of the fingers, and the foreign body removed by the aid of a curved pair of esophageal forceps. Great care should be taken to sponge away any mucus that escapes from the passage. After the foreign body is removed, the wound in the esophagus should be closed with two layers of catgut sutures, the outer row being Lembert stitches. A small drain is now carried down to the esophagus and all of the deep structures sutured in their normal position with catgut and the skin approximated with horsehair stitches. The patient should receive no food or liquids by mouth for a week or ten days. In well preserved patients the nourishment and fluids can be administered per

rectum. In very weak individuals the nourishment may be given by passing a tube through the nose down into the stomach.

The prognosis in cases of esophagotomy depends mostly upon the time of operation. If this is done within the first 24 to 48 hours the prognosis is good. If after this time, and ulceration or perforation has taken place, the prognosis is very grave.

Gastrotomy. Removal of foreign bodies through the stomach is justifiable in all cases in which such body is situated too low in the thoracic portion of the esophagus to be reached by esophagotomy, and which cannot be removed by other means. It is indicated, therefore, where the foreign body is situated more than 26 cm. from the teeth, as well as those in the cardiac end of the esophagus, especially in large angular or irregular-shaped bodies.

In performing gastrotomy for foreign body in the esophagus, an incision is made through the edge of the left rectus abdominis muscle or obliquely along the costal margin. Upon opening the peritoneal cavity the intestines should be packed away by means of sterile gauze pads to guard against soiling the peritoneum by any leakage from the stomach. The dome of the stomach is now brought forward and out of the peritoneal cavity if possible. The stomach wall is grasped with mouse-toothed stomach forceps and then incised. The stomach contents should be removed by packing dry gauze pads in and out through the opening in the stomach wall. The lower end of the esophagus is now explored by passing one finger through the stomach. The edges of the stomach wound should be held well beyond the edges of the abdominal wound and a pair of esophageal forceps passed through this opening up into the esophagus and the foreign body extracted, if possible. In the more difficult cases, where various procedures are necessary in order to loosen and bring down the foreign bodies, it is most practicable to enlarge the incision and pass the whole hand into the stomach, as recommended by Richardson. If the foreign body cannot be reached with the finger and removed by the aid of forceps, the string method, as used by Bull and Finney, should be tried. A small sound or bougie is passed either through the mouth, or from below through the gastrotomy opening. A string which has been armed with a small sponge or piece of gauze is attached to the end of the sound and pulled back through the esophagus. An attempt is now made by pulling this sponge through the esophagus to bring the foreign body up and out through the mouth, or pull it downwards into the stomach. After the foreign body has been removed, the management of the opening in the stomach depends upon the amount of traumatism of the esophagus.

If the foreign body is removed early and with little injury to the esophagus, the wound in the stomach should be completely closed by first placing a Connell suture through the two edges and covering the area with a Lembert stitch. In case the foreign body has been present for a considerable time so that it might have caused an ulcerated condition, or if the esophagus is injured considerably during the removal of the foreign body, then a temporary gastrotomy should be done for the purpose of administering food until the esophagus has recovered from the injuries. The gastrotomy should be planned so that the opening in the stomach will close spontaneously in a short time. This can be accomplished by carefully folding the serous surface of the stomach inwards around the feeding tube so there cannot possibly be any eversion of the mucous lining of the stomach. If this is done in the manner indicated the fistula in the stomach will close in a short time after removal of the feeding tube.

The most important complications which follow the swallowing of foreign bodies are hemorrhage and phlegmonous processes resulting from injury to the esophagus, ulceration, perforation or gangrene of the esophagus followed

by a phlegmonous process which may lead to suppuration in the pleura, in the mediastinum, in the loose connective tissue between the vertebral column and the esophagus or result in pneumonia or gangrene of the lungs.

With the existence of any of the above complications the prognosis is usually unfavorable.

STRICTURE OF THE ESOPHAGUS

Of the actual strictures of the esophagus, those caused by carcinoma are most frequent, the next in frequency being cicatricial stenosis, the result of the healing of an ulceration. The latter is produced by some form of traumatism, such as the swallowing of caustic alkali, acids or hot fluids. It may be caused by a wound or due to prolonged lodgment of a foreign body. It is occasionally due to typhoid ulceration.

The most common cause, and especially in children, is the accidental swallowing of concentrated lye. In adults carbolic acid, ammonia, etc., are frequently taken, but the immediate mortality is high, so only a small proportion live to develop a cicatrix. Occasionally the breaking down of a syphilitic gumma may leave an ulcer, and the healing thereof cause a stenosis. Tubercular ulceration of the esophagus is very rare. The healing of an ulcer of the cardia extending into the esophagus may in rare cases result in a cicatricial stenosis of the esophagus. Spasmodic stricture of the esophagus is not a rare condition and must always be kept in mind when considering cases of obstruction of this tube.

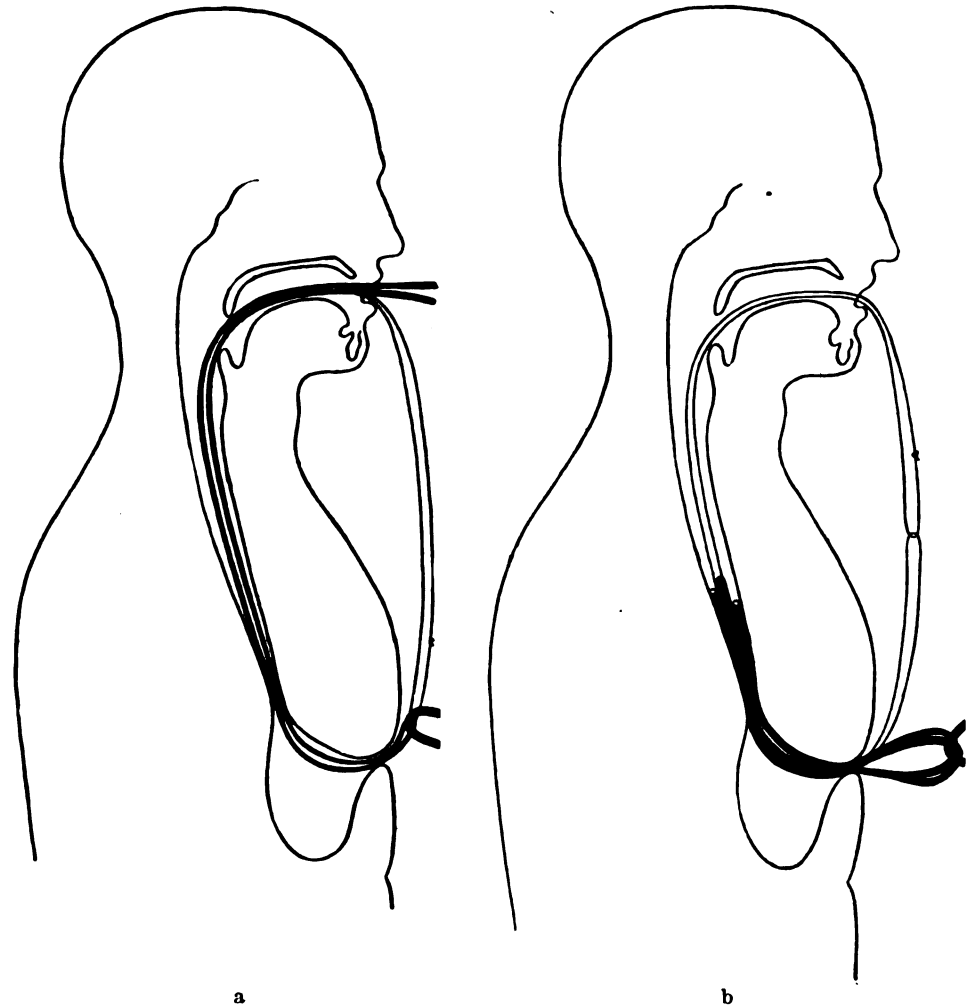
A pressure stenosis of the esophagus may result from extra-esophageal conditions such as tumors involving the thyroid body, tracheal and mediastinal glands, aneurysms, pericardial effusions, peri-esophageal abscess and spondylitis.

Although strictures may occur at any part of the esophagus, they are most frequently found at the site of the three natural constrictions, viz., at the entrance, at the level of the bifurcation of the trachea, and in the region of the hiatus.

Symptoms. Difficulty in swallowing is present in all cases of stricture of the esophagus. The degree of dysphagia depends upon the degree of stenosis. In cases of cicatricial stenosis the narrowing usually develops slowly, and the dysphagia comes on gradually. At first the patient experiences difficulty in swallowing solid food, especially meat. Early in the disease there is usually a sense of pain or discomfort in the esophagus at the point of the stricture, especially during the act of swallowing. Occasionally the patients locate the stricture incorrectly, as the pain may be referred to the region of the sternum and circoid cartilage when the obstruction is in the lower portion of the canal.

As the stenosis increases the difficulty in swallowing becomes more marked, and the patient soon develops a rather characteristic symptom of being careful to take only a small amount of food at a time, and then swallowing slowly. They frequently gag, and then carry out certain motions with the head. There is frequently regurgitation of food; if the obstruction is high up this takes place immediately, if lower down, a short time may intervene before the regurgitation occurs.

Where the obstruction is very marked mucous and swallowed saliva accumulate, constituting a great annoyance to the patient by being frequently regurgitated into the mouth. As soon as the obstruction is pronounced, loss of weight takes place from lack of sufficient nourishment.



DILATATION OF STRICTURE OF ESOPHAGUS.

(a) Shows continuous double thread of heavy braided silk passed through mouth, pharynx, esophagus, stomach, gastrostomy wound, and from this to the mouth, a rubber drainage tube being drawn through the loop in the string for the purpose of dilating the stricture, and a second drainage tube being drawn through the loop made by the first.

For the dilatation of a stricture in the lower end of the esophagus it has been suggested that the stomach be opened after the method just described and that then a dilator formed after the pattern of a glove-stretcher be passed through the stricture from below and the latter very thoroughly and repeatedly dilated; great care being taken however not to tear but simply to stretch the tissues, which can be accomplished only if the dilatation is made very slowly and is very frequently repeated.

(b) The same as (a), a larger double rubber drainage tube having been drawn through the loop in the first and left in the stricture temporarily for the purpose of dilating the latter.

The number and the size of these tubes may be increased until the desired degree of dilatation has been accomplished. It is important that they should be left in place in the stricture for several minutes after they have been drawn into this in order to secure the dilatation which comes from the elasticity of the rubber tubing.

Diagnosis. In mechanical stricture of the esophagus there is present a series of symptoms which are self-evident; of these the dysphagia and regurgitation of food are the most prominent. When a patient complains of difficulty in swallowing, or of vomiting at the time of eating, we should put him to the test and observe what happens during the ingestion of food and drink. Even though the obstruction has existed but a short time, we will observe that the patient has learned to eat slowly, to take only small bites of food and to masticate very carefully. If the stenosis is very marked even liquids will be taken slowly and it will be evident that it is an effort to cause the food to go down. If the patient is urged to eat more rapidly he will say that it is impossible. If eating is forced there will be a regurgitation of food usually mixed with mucus. This takes place without any effort on the part of the patient and is very different from the expulsive evidences which accompany ordinary vomiting. The patient can practically always distinguish the difference between the act of vomiting and that of regurgitation of food.

If the history indicates the presence of a stenosis we can confirm the diagnosis by passing a stomach tube or bougie. Before such instruments are used a careful examination should be made to determine if there is any contraindication to their passage.

The presence of an aneurysm or high grade arterio-sclerosis or pronounced heart incompetency render the procedure unsafe.

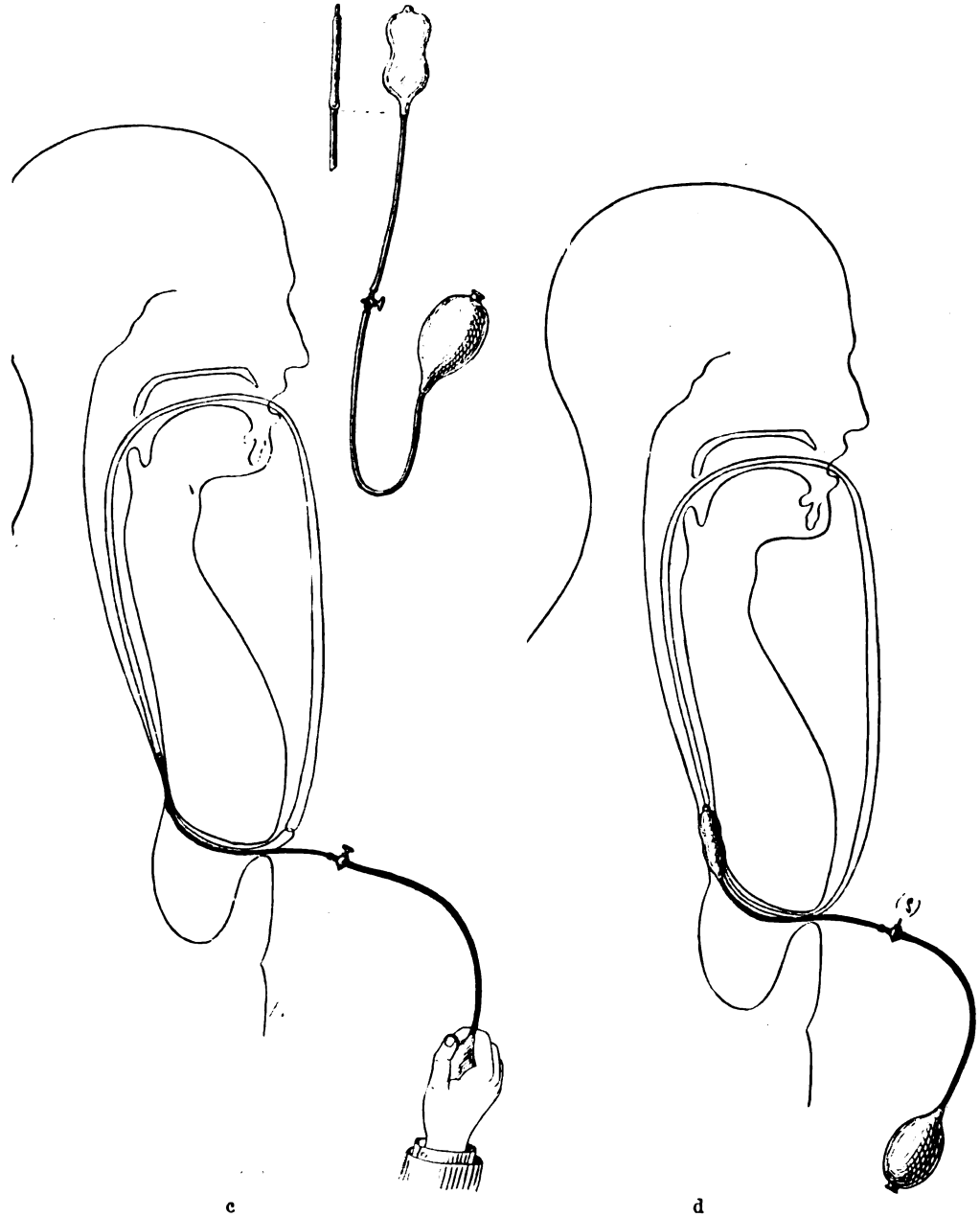
As a rule it is best to pass a soft stomach tube first, but the exact location and degree of obstruction may be more accurately determined by using bougies with olive tips.

The diagnosis and location of an esophageal stenosis are usually easy, but to determine the exact nature of the obstruction is often a difficult matter. In adults carcinoma is by far the most common cause of stricture. It is characterized by the symptoms described above, its onset is usually gradual, although the inability to swallow solids may come on suddenly. The course of carcinoma is progressive, there is a gradual loss of weight and later cachexia. Metastatic growths should always be looked for, although they are rarely of value in the early diagnosis. As there is a tendency toward early ulceration in carcinoma the presence of blood in the stools is an important diagnostic sign. In carcinoma the passage of even a soft stomach tube usually causes bleeding on account of its ulcerating surface.

In cicatricial stenosis there will be a gradual and persistent obstruction with the absence of the above symptoms. There is usually a history of swallowing caustic acids or alkalies. This history, together with the presence of a firm obstruction, as determined by passing a bougie, will usually suffice to make the diagnosis of cicatricial stenosis.

Use of X-ray. The exact location of an obstruction of the esophagus can usually be determined by the X-ray, which at the same time may reveal the nature of the obstruction. Frequently a better understanding of the condition can be determined by fluoroscoping the patient than by taking an X-ray photograph. The patient is placed behind the X-ray screen in the standing position, and is then asked to swallow a glass or two of buttermilk and bismuth. As the patient swallows, its passage along the esophagus can be noted. After a careful observation of the course of the esophagus has been made with the screen the X-ray photograph is taken.

Treatment. Much can be done to prevent the formation of troublesome strictures following traumatisms of the esophagus by treating the condition before contraction takes place. After the swallowing of caustic substances, systematic sounding should be instituted in from two to four weeks. Foreign bodies should not be allowed to remain in the esophagus until ulceration has taken place.



DILATATION OF STRICTURE OF ESOPHAGUS.

(c) Barnes' dilator introduced after a partial dilatation has been accomplished by the methods illustrated in Figs. A and B. The stop-cock enables the surgeon to distend the bag and to keep it distended for any desired time while engaged in the stricture.

(d) Barnes' uterine dilator in position; (s) shows the stop-cock, which maintains a constant degree of dilatation.

When the obstruction is at the point indicated in this figure, that is opposite the point at which the esophagus passes through the diaphragm, it has been suggested that the stricture may be due to circular constriction of the muscles of the diaphragm surrounding the esophagus, and in one case at least the careful division of these muscle bands has resulted in a cure of the stricture.

Dilatable strictures. Gradual dilatation is the operation of choice in these cases. If the stricture is not too tight the woven flexible bougies are suitable for this purpose. The bougie is lubricated with vaseline, olive oil, or glycerine and passed after the method described in the part upon examination of the esophagus. In the tighter strictures a bougie with a whalebone stem, to which may be attached increasing sizes of ivory, olive-shaped tips, will be found most valuable. The tip should be made long and tapering so that it will enter the stricture with more ease than the ordinary olive tip. There are many cases in which the woven flexible bougie or the olive tips cannot be passed and the surgeon is apt to pronounce the case one of impermeable stricture. However, in these cases with care and gentleness a filiform bougie can easily be passed, even though several sittings are required. In such cases several small filiform bougies, on one end of which threads are cut so as to be attached to a flexible dilator, as shown in the plate, should be inserted into the esophagus against the stricture in the same manner as filiforms are inserted into the urethra. Now by manipulating first one bougie and then another, one will usually slip through. The tapering flexible bougie is now attached to the filiform which serves as a guide while the bougie is pushed on through the stricture. After the filiform has been passed a few times, the passage of the woven flexible bougie or the olive tips can probably be accomplished. These should be passed in increasing sizes at intervals two or three times a week. After a few days, when the patient has become accustomed to this procedure, the largest flexible bougie passed should be left in place for a period of five to fifteen minutes.

Many months are usually required for thorough dilatation of one of these strictures, and after the patient is apparently cured, sounds should be passed occasionally for several years.

Non-dilatable strictures. In strictures which are impermeable from above, or cannot be successfully treated by dilatation through the mouth, the treatment depends upon the condition of the patient and upon the location of the stricture. If the patient is in an exhausted state from prolonged starvation, a temporary gastrostomy should be performed, and the patient nourished in this way until his general condition has improved. By this means rest is given to the affected parts and later on it may be possible to dilate the stricture from above, and if not, some form of retrograde dilatation may be used.

The most common, as well as the most serious, strictures are those at the lower end of the esophagus. The best method of dealing with these is some form of retrograde dilatation.

Esophageal strictures which are impermeable from above, will almost invariably permit the passage of a bougie from below, because the pressure of the food in trying to pass down the esophagus renders the canal basin-shaped, while on the distal side it is funnel shaped, thus naturally a bougie will pass more readily upwards through the stricture.

The Ochsner method. The same incision is made as used in ordinary gastrostomy. The stomach wall is brought out of the wound and a purse-string suture applied to describe a circle one and one-half inches in diameter. An incision is made in the stomach wall large enough to admit one finger. A filiform bougie is now passed through the stricture either from above or in a retrograde manner. A silk cord is attached to the end of the bougie and pulled up through the esophagus and out through the mouth. A stronger silk cord is attached to this one and in turn is drawn through downwards. This performance is repeated until a very powerful silk cord has been drawn through double and tied upon itself, as shown. The feeding tube is fastened in the stomach by tying the purse-string. The silk cord is left in place, passing

around through the esophagus and stomach and out alongside the feeding tube, so that it cannot be dislodged by an accidental manipulation. The operation is then completed by suturing the stomach to the peritoneum and transversalis fascia.

The feeding tube is left in place for a few days while the stomach is becoming thoroughly attached to the abdominal wall, during which time the patient receives an abundance of nourishing food.

The dilatation is now begun in the following manner; by means of the continuous double cord another cord is carried through the stomach into the esophagus and out through the mouth. This cord should again be double so that a rubber drainage tube may be looped into it and drawn through the stricture, as shown. In this figure, however, the rubber tube is looped directly upon the original silk cord, which is not a safe practice, because in case the cord should break it might be difficult to replace it, while there is no danger of its breaking in simply carrying through another cord.

The rubber will stretch out into a thin body when drawn through a tight stricture, but when relaxed will act as a powerful dilator. The size of the rubber tube may be increased, or any desired number may be drawn through the stricture at the same time, as the calibre of the latter increases. The rubber tubes may be drawn back and forth, the first one is drawn through the mouth and out of the opening in the stomach by means of the silk cord. The dilatation can now be carried on by looping a larger rubber tube through the loop of the other tube and by means of the latter draw the larger tube up through and out of the mouth, and then repeat this until as large a tube as desired is drawn through the stricture. This, however, requires a large opening in the stomach, which is not necessary if the tubes are simply looped into the silk cord and by alternating the direction of the pull the tube is drawn out by its free ends and in by the silk loop. Later on, a Barnes dilator in a collapsed condition may be drawn into the stricture. In this plate the dilator was drawn up from below, but it can be drawn down from above with no more difficulty. The fact that the dilator is engaged in the stricture can be recognized by the difficulty one experiences in drawing it into the narrow opening, and the shoulders upon the bag create a tendency to keep it from slipping beyond the stricture.

When once in place the Barnes' dilator may be inflated with air by means of a rubber bulb. The patient's own feelings must serve as a guide to the degree of dilatation it is safe to make use of at any given time, and the length of time it is wise to leave the dilator in place.

Sippy has constructed a dilator superior to the Barnes, which can be used in the same manner. This consists of a rubber bag, about three and one-half inches long, encased in a silk bag, which limits accurately the distension produced. When inflated with air the circumference of the silk bag is about 15 cm. The dilating force is accurately controlled by the silk bag, and the maximum pressure exerted at the point desired. The silk bag is covered with a rubber bag to prevent friction.

If simple dilation, either by the use of the rubber tubes or the Barnes dilator, does not expand the stricture rapidly enough, the edges of the stricture may be rendered tense either by drawing a number of rubber tubes into the stricture or by the inflated bag, and then using the silk cord after the fashion of a chain saw, similar to the method of Abbe, thus cutting the edges of the stricture.

After a considerable degree of dilatation has been accomplished it is well

to attempt the passage of esophageal bougies from above. These should be passed every day at first, then once a week for several months and then once a month for many years. The patient may be taught to pass the bougies himself and then to report personally to the surgeon occasionally, because he often imagines that he has succeeded in passing a bougie when he has only introduced it down to the stricture.

After removing the feeding tube in these cases in which an adequate passage through the esophageal stricture has been established by dilatation, the opening in the stomach will usually close spontaneously.

Abbe's string cutting method. The abdomen is opened and the anterior wall of the dome of the stomach is brought up and sutured to the edges of the abdominal wall. An opening is made in the stomach and two fingers are inserted into the viscus and passed along its anterior wall to locate the opening of the esophagus.

Abbe (*Med. Rec.*, Nov. 20, 1907) calls attention to the fact that it is often difficult to locate the esophageal opening. In connection with this Abbe states: "This has been interesting to me from a physiological point of view. We ordinarily think of the stomach as pictured in anatomy, showing a funnel-shaped expansion of the esophagus where it joins the stomach wall. It has never been my experience to find this condition in the living stomach. As the finger passes back and forth over its upper interior aspect, one feels an even surface more like the interior of any dome-shaped cavity. This surface is maintained by the circular sphincteric muscle layers, and it is not until a moment's pressure of the finger at the right place causes them to yield that it slips upward into the esophagus.

"I have never seen this point stated in surgical works, and it has interested me as representing an always present physiological condition which prevents food regurgitation."

When the esophageal opening has been located, a long filiform whale-bone bougie guided by the index finger is passed up along the esophagus from the stomach to the mouth. To the end of this a heavy silk string is tied and pulled up through and out the mouth. A tapering bougie is now passed up along the string and through the stricture until it becomes wedged tight in the strictured portion. The string is now pulled backwards and forwards like a saw, thus cutting the tight stricture band. As the stricture gives way, the bougie is passed farther up until it again becomes tight and the string sawing is repeated until a large bougie can be passed from the stomach to the mouth. In place of passing the bougie up along the string, as described above, a second string may be drawn through the esophagus to the lower end of which a Billroth dilating bougie is tied, and by means of this string the bougie is drawn upwards until it becomes tightly engaged in the stricture and then the sawing process used as above.

The fundamental principle of this operation is, that the dilator must be pressed tightly into the stricture in order that the string moving to and fro may eat its way through the stricture. No tissue will be affected by the string, except where it is on the stretch.

The gastrostomy opening may be closed immediately after the cutting process is completed, or it may be left open for a few days until it is demonstrated that a large-sized bougie can be readily passed from above. Bougies should be passed every other day at first, then weekly, then once a month for a year and after that once each year.

Billroth's method. A filiform bougie is passed into a gastrostomy opening and up through the stricture to the mouth, or out through an external esopha-

gotomy opening, and a strong thread drawn down through and out of the gastric opening. Then to the lower end are fastened in succession conical bougies whose tips are capped by a metal point into which the string is tied. From the smallest to the largest ones they are thus safely drawn up through the stricture, with no danger of perforating the wall of the esophagus.

In performing any of the retrograde methods of dilatation one is apt to have difficulty in passing the first string through the stricture. It may not only be impossible to pass a bougie from above, but one may also experience great difficulty in finding the cardiac opening. In such cases a silk thread may be floated through from above, as advocated by Dunham. This is accomplished by having the patient swallow a silk thread down to the stricture. The patient is now given a swallow of water. As this trickles down through the stricture it may carry the thread through with it, and then the thread can be fished out through the gastric fistula.

DIVERTICULA OF THE ESOPHAGUS

Diverticula of the esophagus are pouch-like sacculations of a portion of the circumference of the tube. The characteristic features of a true diverticulum are sharply-defined, pouch-like protrusions of the esophageal wall, lined with mucous membrane.

The symptoms vary according to the location of the diverticulum. If it is situated in the cervical portion the early symptoms may be only slight, such as dryness and irritation about the throat. Later the sensation of a foreign body may be present. As the sacculation becomes larger, the food accumulated therein crowds against the esophagus and obstructs its lumen, causing difficulty in swallowing and regurgitation of food. In about one-third of the cases a tumor can be discovered in one side of the neck after eating.

The majority of the patients learn that by holding the head in a certain position they may be able to swallow; others learn to empty the sac by making pressure upon it with the hand. It frequently requires hours for a meal. In some cases a peculiar gurgling sound is heard during the act of swallowing. In most cases there is a constant retention of particles of food in the sac, causing a fetor which may become intolerable. It is often noticed that the patient can swallow better during the early part of the meal. As the sac fills, it crowds upon the esophagus and obstructs its lumen.

Diagnosis. The diagnosis can usually be made from the above symptoms. The history of the gradual development of these disturbances and the regurgitation of unaltered food should always arouse suspicion of a diverticulum. If a tumor develops in the neck during a meal and can be emptied by pressure, it is still more probable that a diverticulum is present. If a bougie is passed, it is usually arrested at a point near the cricoid cartilage. If the bougie is slightly withdrawn and the direction of its point changed, it may pass on into the stomach. It frequently happens that a bougie may pass readily one day and not the next. Occasionally when a bougie has been introduced into the diverticulum a second bougie may at the same time be passed on into the stomach. This would be impossible if there was a stenosis. Bismuth suspended in oatmeal gruel may be administered and an X-ray picture taken. If the sacculation is sufficient the picture will show the location and approximate size.

The symptoms of the deep-seated diverticula are vomiting or regurgitation of food during or soon after the meal. After vomiting the patients are again able to eat for awhile. Occasionally it is found that after eating a small

quantity of food there is a sense of weight or pressure in the region of the sternum. These disturbances gradually increase and larger quantities of food are vomited and less food enters the stomach, so that the patient gradually becomes emaciated.

The diagnosis is based upon the clinical history and examination with bougies. For this purpose a bougie with a curved tip, like a Mercier catheter, is most convenient. With these bougies it is usually easy to pass by the diverticulum or by turning the point pass into the sacculation, and also determine whether the diverticulum is situated to the right or the left. A bismuth mixture may be administered and an X-ray photograph taken for the purpose of determining the size and location.

Treatment. The treatment of esophageal diverticula in the cervical region may be non-operative or surgical. The non-operative consists in the persistent use of sounds and stomach tubes. Permanent benefit to the patient can rarely be expected by this method.

The surgical treatment may be palliative or radical. The palliative treatment consists in performing a gastrostomy to secure a means of administering food. When the patient is in a bad general condition, it may be advisable to perform a temporary gastrostomy in order to be able to improve his general condition preparatory to the radical operation.

This also affords a method of administering food other than by the mouth, until the wound in the esophagus has healed.

Extirpation of the sac, as first suggested by Kluge, is considered the best method for the permanent cure of this condition. The chief danger of the operation seems to be from infection, which may occur from the contents of the sac during its removal, or from leakage from the esophageal wound after it has been sutured.

The technique of the operation is as follows: An incision is made along the anterior border of the sterno-cleido-mastoid muscle from the level of the hyoid bone to the clavicle. The esophagus is reached by means of blunt dissection. No vessels of any importance are encountered except the superior thyroid and occasionally the inferior thyroid. Either one or both of these may be ligated. The thyroid gland can be drawn to one side and if not enlarged will not be in the way. The sac when located should be carefully enucleated like that of a hernia. The most important step in the operation is the closing of the esophagus after removal of the diverticulum. Probably the best method is that similar to an intestinal suture in separate layers, first the mucosa, then muscular coat and finally the adventitia, using catgut for the first two layers and silk for the last suture.

It is advisable to drain the wound by carrying a piece of iodoform gauze or cigarette drain from the esophageal suture out through the skin incision.

The treatment of epibranchial diverticula and those located just above the diaphragm is unsatisfactory. Irrigation with mild antiseptic solution will prevent irritation and ulceration of the mucous membranes. These irrigations and the passage of bougies often afford considerable relief.

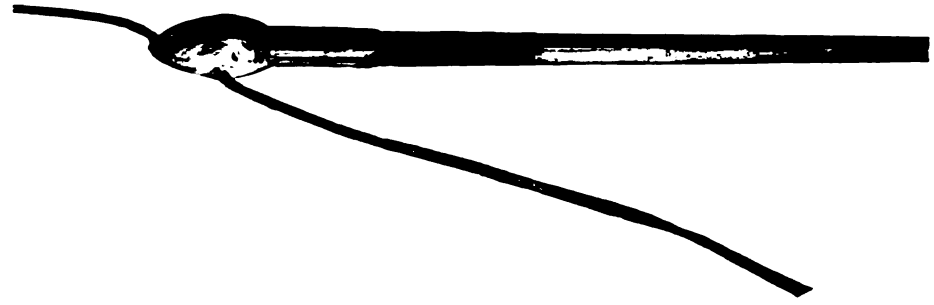
IDIOPATHIC DILATATION OF THE ESOPHAGUS

By idiopathic dilatation of the esophagus is meant a dilatation with no ascertainable organic cause. The esophagus usually becomes dilated throughout a large portion of its extent, sometimes involving practically its entire length in a spindle-shaped or cylindrical manner. Our lack of knowledge of the etiology of this condition is indicated by the variety of names under

which the cases have been reported, such as cardiospasm, idopathic, fusiform, diffuse dilatation and dilatation without anatomical stenosis. Clinically, as far as we can judge from the history of these cases, a definite spasm of the cardia seems to be one of the earliest manifestations of the disease.

Etiology. The cause of the spasm is a matter of speculation. In the majority of the cases a definite etiological factor cannot be found. A few cases have been reported associated with gross lesions of the esophagus such as ulcers, fissures, carcinoma of the cardia and of the stomach. Plummer has found three cases of carcinoma complicated by cardiospasm and one case of hourglass stomach due to syphilis with secondary cardiospasm. In his study of forty cases of cardiospasm only three of them had neurasthenic symptoms, and evidence of esophagitis previous to the onset of the cardiospasm could not be elicited from any of them.

Symptoms. Three stages. The symptoms of cardiospasm may be divided into three stages; first, cardiospasm with some difficulty in swallowing but no regurgitation of food; second, cardiospasm with immediate regurgitation of food; third, cardiospasm with the dilated esophagus with retention of food in its dilated portion and its regurgitation at irregular intervals.



PLUMMER'S WHALEBONE STAFF WITH IVORY TIP DRILLED AND THREAD PASSING THROUGH SAME.

In the majority of cases the first attack of spasm occurs suddenly while eating. A spasmodic choking sensation is experienced at some point along the course of the esophagus, most often located in the region of the cardia. This sensation is rarely described as a pain and may be referred entirely to the epigastric region or to the upper portion of the esophagus. Sometimes the spasm is described as a delay in the passage of food, or that the food "sticks" beneath the sternum. Soon it is noticed that the patient eats very slowly and finds it difficult to swallow. It may be necessary to wash the food down with water. The patient may go through certain movements of the body and arms or take deep breaths to force the food down.

In the second stage the patient has regurgitation of food which occurs immediately after swallowing. During the early portion of the history the attacks occur periodically, but with varying degrees of intensity and with remissions or intermissions covering days, weeks, months or even years. The condition pursues its slow and unmodified course. As the cardiospasm becomes more complete, the regurgitation of food and secretions of the esophagus come on more frequently and more regularly.

In the third stage after dilatation takes place the spasmodic choking sensation may be absent. The patient is able to take the first portion of his meal quite comfortably, but the food is retained in the dilated esophagus instead of passing on into the stomach. After the sac is filled, further food is regurgi-

tated or forces some of the preceding portion into the stomach. Of the contents of the esophagus at the close of a meal, the more fluid portion may gradually slip through into the stomach. The solid food with mucus is usually regurgitated later at irregular intervals. Solid food like meats may remain in the esophagus several days. Plummer states that the sac never completely empties itself and that on many occasions he has withdrawn from two to sixteen ounces of food after the patient has fasted for twenty-four to thirty-six hours. The regurgitation is often looked upon as vomiting both by the patient and the physician. Some patients insist that the food enters the stomach but will not stay, while others state that it lodges beneath the sternum. They practically all complain of a sense of weight and discomfort in the chest and will also maintain that the regurgitated food is not sour.

Diagnosis. The diagnosis of cardiospasm is apt to be difficult in the beginning, especially in patients who might be supposed, on account of their age, likely to suffer from carcinoma of the cardia. But in advanced cases the diagnosis should not be difficult. Generally the diagnosis can be premised from the history. Without previous warning there is sudden difficulty in swallowing, or the patient unconsciously gets to nibbling and following each deglutition of solid food with a swallow of water. At first liquids are often swallowed with greater difficulty than solids. After dilatation takes place the obstruction is present alike to liquids and solids.

An important diagnostic feature is that there may be little or no obstruction to the passage of a bougie even in cases in which a large quantity of food is retained in the esophagus. In the average case when a sound is passed, it will be temporarily arrested at the cardia and then when slight pressure is made it passes on into the stomach. A large bougie will often pass as easily as a small one. This is not true in case of an organic stricture. For these cases Plummer has devised an olive-tipped bougie passed on a silk thread as a guide.

The patient slowly swallows six yards of silk thread. This passes down through a sufficient number of coils of intestine to prevent its withdrawal on being pulled taut. He has the patient swallow three yards in the afternoon and three yards on the following morning. In this manner the first portion forms a snarl in the esophagus or stomach, which passes out into the intestines during the night, the remaining portion passing without snarling. The olive tips for threading on this string are drilled from the tip to one side of the base. The olive tip after being fastened on the end of a whale-bone staff is threaded upon the silk thread protruding from the mouth. The string is now pulled taut as the sound is passed on down the esophagus. The silk thread as a guide points the bougie directly into the cardiac orifice and avoids that resistance encountered in sliding the olive along the flaring wall of the esophagus or the straightening out of some fold just as it is about to enter the cardia.

The character of the resistance met with at the cardia is of the utmost importance in the differential diagnosis of organic and spasmodic stricture of that part.

Excitement, overwork and worry are factors that may increase the spasm. The patient frequently awakens at night and finds food upon the pillow or finds his mouth and posterior nares filled with former contents of the esophagus. In organic stricture the retention of food and mucus is slight in comparison to what it may be from the result of cardiospasm. X-ray pictures of the dilated esophagus may be obtained by having the patient swallow bismuth subnitrate suspended in oatmeal gruel, until the choking sensation occurs, then the part is photographed.

Treatment. Forcible dilatation is the best method of treating cardiospasm. Until recently the treatment of cardiospasm has consisted in such ineffectual measures as looking after the patient's general condition; placing him under the best hygienic care; restricting the diet to fluid, non-irritating substances; effervescent drinks; administering sedatives; the passing of large bougies and, as a last resort, performing a gastrostomy. The passage of bougies has been followed by good results in some cases, but if there is much dilatation of the esophagus such results are only temporary. It is impossible to actually stretch the orifice by passing sounds, because one cannot pass a bougie large enough to produce actual stretching of the muscle fibers.

Sippy dilation method. Other means have been devised to stretch the cardia. Sippy has constructed a dilator consisting of a rubber bag about 10 cm. long encased in one of silk, which limits the distension produced. When inflated the circumference is about 15 cm. With this bag the maximum pressure is exerted at the desired point. The silk covering is encased in a rubber cover to prevent friction. A long non-elastic rubber tube is attached to the bag at one end and connected with an air pump at the other. It is essential to measure the amount of pressure within the bag during the dilatation and this is accomplished by connecting a column of mercury to the tube between the bag and the pump. The exact distance of the cardia from the incisor teeth is measured by a bougie. The bag in a collapsed condition is carried down into the cardia by means of a whale-bone staff. The dilatation is now accomplished by distending the bag with air. The cardia will stand a pressure of 500 mm., but Sippy has found that from 100 to 300 mm. of pressure exerted for a period of three minutes will be sufficient to afford relief in most cases. The number of dilatations ranges from one to ten. This method of treatment is used without anesthesia.

The immediate results from this treatment are most striking. Usually the patient is able to take most any kind of food at the first meal following the dilatation. Sufficient time has not elapsed since the introduction of this procedure to formulate definite conclusions as to the ultimate outcome. In forty cases treated by Plummer, twenty-nine have remained well and in several of these the time elapsed since the dilatation is over two years. In the eleven cases in which the symptoms returned, the time elapsed after the treatment varied from three to seven months. There has been no recurrence in any case which remained well for one year.

SURGERY OF THE STOMACH

General considerations. Stomach surgery at the present time is instituted to a very large extent for the purpose of overcoming faulty drainage of this organ. In various ways the pylorus may become obstructed, so that the contents of the stomach cannot pass on into the intestine in a normal way, and as a result there is first a compensatory hypertrophy of the walls, then a dilatation with an accumulation of mucus and food remnants which are sure to undergo decomposition. This is accompanied by the formation of gas, which will further increase the distension of the stomach. This in turn produces a deformity in the outlines of the stomach, the latter taking the form of a pouch bending downward, which increases the obstruction to the pylorus, because the food has to be elevated a considerable distance before it reaches the exit.

The normal stomach extends obliquely across the abdominal cavity, the cardiac end being much higher than the pyloric. The lesser curvature of the stomach extends almost vertically downwards for the first two-thirds of its

extent, slanting only very slightly toward the right, beginning at the point of entrance of the esophagus, almost the entire curve being confined to the third nearest the pylorus. The greater curvature is more uniform and extends across the abdomen at an average angle of about 45°. It is important to bear this in mind, because it explains to a great extent the increase in the obstruction resulting from the element of dilatation, which is in itself the result of an obstruction to the pylorus. It further explains some of the unsatisfactory results which are apt to persist after the primary obstruction of the pylorus has been relieved by a plastic operation to enlarge this orifice.

The pylorus which has been thus enlarged would readily permit the stomach contents to pass if the stomach still had its normal form and position, but with the greater curvature forming a deep pouch, which has resulted from the obstruction, the emptying of this organ is greatly interfered with, even if the constriction of the pylorus no longer exists.

The principal diseases of the stomach that are amenable to surgical treatment are carcinoma, gastric and duodenal ulcers and their complications.

Gastric and duodenal ulcers will be considered together because the stomach and duodenum belong together embryologically, anatomically and physiologically, and are very closely related pathologically.

Embryologically they are formed from the foregut, the lowest end of which is marked by a more or less distinctly developed sphincter-like arrangement of the circular muscle fibres located from two to ten centimeters below the entrance of the common duct into the duodenum.

Anatomically they are separated by the pyloric sphincter, which makes itself known to a marked extent only when the stomach contains food.

Physiologically both the stomach and the duodenum serve the purpose of preparing food in such a manner that it can be readily absorbed during its passage through the remaining portion of the alimentary canal. There is but very little absorption of food as it passes through these cavities.

Functions of the stomach. The stomach has five clearly defined functions which must be borne in mind in the surgical treatment of this organ.

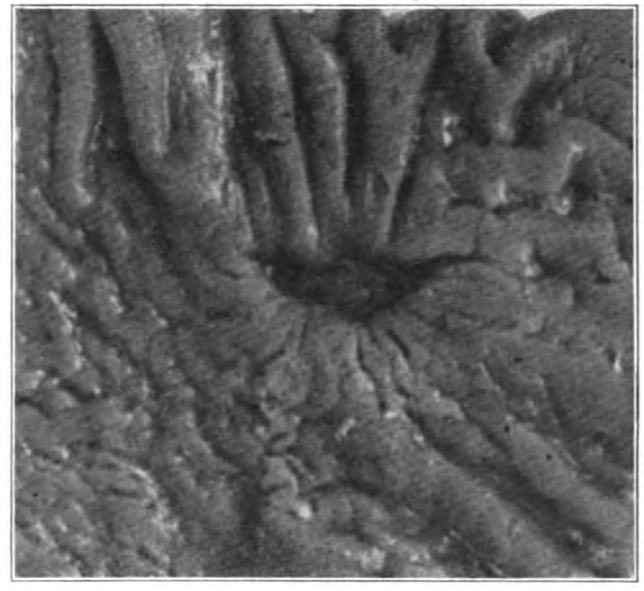
1. It stores the food taken at one meal.
2. It secretes the digestive ferments which act in an acid medium which it also supplies in the form of free hydrochloric acid.
3. It acts as a mixing machine which saturates the food with the digestive ferments and hydrochloric acid.
4. It grinds the food into the proper consistency for the next step in the course of digestion.
5. To a very slight extent it absorbs some of its contents.

The duodenum serves simply as an extension of the stomach in which small portions of the food are again subjected to a mixing process, this time with the alkaline bile and pancreatic juice.

In the treatment of gastric and duodenal ulcers, it is of the greatest importance constantly to bear in mind these anatomical and physiological facts, because it is plain that every surgical interference must in a measure disturb the normal anatomical conditions, and this in turn must result in physiological changes which are abnormal. Primarily gastric surgery deals with the relief of obstruction of the pylorus which is in some way secondary to gastric ulcer.

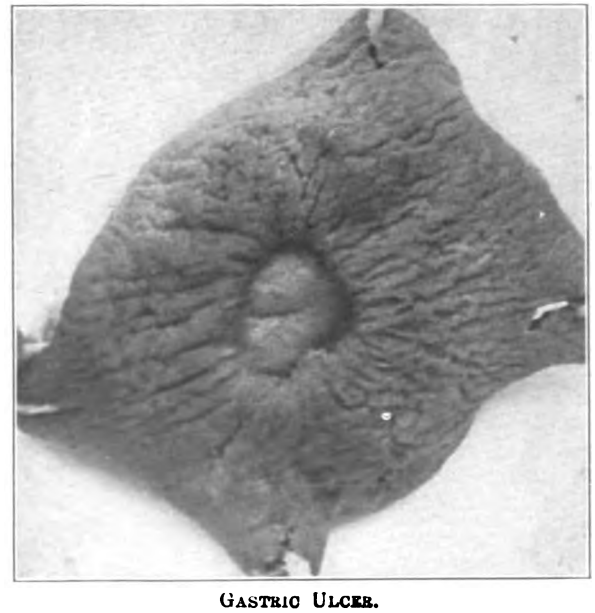
Etiology of gastric ulcer. It has been accepted by those who have had the greatest amount of experience in the treatment of gastric ulcer that traumatism from within is the chief exciting cause.

A vast majority of these ulcers occur in the pyloric end of the stomach



GASTRIC ULCER.

Typical chronic gastric ulcer produced artificially by Friedman and Hamburger (*Journal A. M. A.*, Aug. 1, 1914), by means of injecting 0.5 to 1 cc. of a 5 per cent aqueous solution of nitrate of silver into the gastric submucosa at various points, causing necrosis of the mucous lining.



GASTRIC ULCER.

Chronic ulcer resulted only in the pyloric end of the stomach because this location is the only part of the stomach containing the three essential etiologic elements: "first, a local destruction of the mucosa; second, an active or over-active gastric juice, and third, prolonged or vigorous contact of the two" by causing hyperperistalsis.

which acts more pronouncedly as the grinding machine and is consequently much more exposed to trauma than other portions of the organ.

Many clinicians and pathologists have attributed gastric ulcer to the presence of thrombosis or embolism. Attention has recently been directed to this etiologic factor again by the excellent work of Prof. Payr (*Archiv. f. Klin. Chir.*, Vol. 84), in which he reviews all of the experiments which have been made during the past half century in this connection.

Another factor which has been under discussion for some time is the theory concerning the presence or absence of certain substances in the blood which make the mucous membrane immune against the digestive action of its own secretions. It has been suggested that in the presence of these bodies a traumatism of the mucous membrane of the stomach will heal while in their absence an ulcer will result.

This seems to be borne out by animal experiments, those of Fibrich and those of Futterer being especially interesting. The latter author seems to have proved experimentally that traumatism of the mucous membrane of the stomach results in ulcer only in the presence of general anemia, and that by overcoming this anemia by treatment these ulcers will heal spontaneously and permanently. So long as there is no recurrence of the anemia there is no recurrence of the ulcer, according to this author.

There seems to be no doubt that duodenal ulcer is due, in the vast majority of cases, either to an extension past the pyloric sphincter of a gastric ulcer, forming what is usually known as the saddle-shaped ulcer of the pylorus, or it may be formed through the corrosive effect of the hyperacid gastric juice, thus virtually becoming a peptic ulcer.

Ulcers of the duodenum also occur as a result of severe burns of the skin and from thrombosis of the vessels supplying the duodenum.

Frequency of occurrence. Mayo and others have demonstrated that there is a much greater relative frequency of duodenal ulcer than was formerly supposed, but the exact proportion has not yet been established. It is likely that many duodenal ulcers have been overlooked in the past.

STOMACH EXAMINATION

Examination of gastric function. Stomach tube. We prefer to use a tube of the type devised by Smithies. (See illustration.)

It is made of pure rubber that will stand boiling, is of sufficient calibre to empty stomachs containing residues, is marked off in centimeters from its distal end and thus acts as a hollow esophageal sound and has no troublesome bulb incorporated into it.

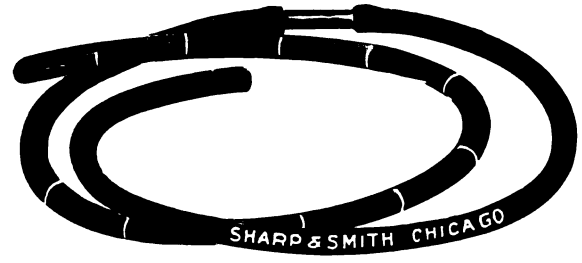
In the passage of this tube the patient sits erect upon a chair, with head inclined slightly forward. His hands are placed flat across the abdomen in the region of the navel. As the tube glides through the cardiac orifice, the patient is directed to lean forward from the hips and exert sudden pressure with the hands across the abdomen. Usually there is a prompt discharge of gastric contents from the stomach tube. If material does not come at once cautious in-and-out movements of the tube, while the patient coughs deeply, generally start the flow. The principles of siphonage maintain it.

Estimation of motility. At 4 P. M. the patient is given two ounces of castor oil in one-half glass of beer or malt extract. At 6 P. M. a generous meal of mixed food. This meal may be chosen according to the patient's desires, but should include four ounces of meat and several leaves of head lettuce. At 9 P. M. the patient eats twenty raw raisins, or a handful of currants. The patient's stomach is emptied at 7 A. M. the following morning by the aid of a stomach tube.

Interpretation. If no food remnants are present in the stomach, it is safe to assume that partial or complete pyloric obstruction, or marked dilatation of the stomach, are absent. Twelve-hour retention is exhibited in about 75 per cent. of cancer cases; 60 per cent. of surgical duodenal ulcers; 40 per cent. of surgical gastric ulcers and in about a like percentage of cases of pericholecystitis with adhesions.

The retention in the above class of cases is generally subject to demonstration on several successive examinations. The degree of retention is not infrequently modified by the factor of pyloric spasm being present or absent in such instances.

Intermittent gastric retention is not infrequently demonstrated in extragastric disease with pyloric spasm, as where the affection exists in the appendix or gall-bladder. In ptosis, unless much atony co-exists, the stomach's emptying power is usually good.



STOMACH TUBE (SMITHIES).

We have found the evidences of retention returned by gastric examination after an eight-to-twelve-hour interval to be a much better gauge of the stomach's ability to pass food through than when an examination for food remnants is made after, say a four-to-six-hour interval.

X-ray method. From two to four ounces of bismuth subcarbonate, or chemically pure barium sulphate, are intimately mixed with eight ounces (cooked weight) of cream of wheat or oatmeal porridge. After a six-hour interval, during which no other food is taken, the patient is examined by the fluoroscopic screen or X-ray plate for evidences of bismuth or barium in the stomach. Where a considerable degree of obstruction to the onward progress of food exists (pyloric stenosis, hour-glass contraction, diverticulum, etc.), part of the shadow-casting meal not infrequently remains in the stomach after six hours. In gastric atony or marked pyloric spasm similar retention is not uncommonly demonstrated. Its demonstration is not constant on several successive examinations in the latter instances.

Estimation of the secretory activity of the stomach. For this purpose a test-meal is administered. We prefer to give one of the following:

1.—Sixty grams of second-day bread: two glasses of water (one of hot and one of cold); or

2.—Two toasted shredded wheat biscuits and one glass of hot water and one of cold; or

3.—Sixty grams of rusk or zweibach and 250 c.cm. of weak tea without cream or lemon and preferably sugar-free.

After the administration of any of the above meals, the patient should walk about, read, or otherwise occupy himself for forty-five minutes. The meal is then removed by the stomach tube.

Interpretation quantity. Normally 40 to 60 cc. should be obtained after forty-five minutes. If less is obtained, and one can be sure that the stomach is empty, hyperperistalsis can be suspected. If more than the above amount is obtained, hypersecretion, or gastric stagnation, or both, are not uncommon.

Chymification. Normal gastric extracts have a pureé-like appearance. If large, coarse or granular bits of test-meal food are present, free hydrochloric acidity is usually low. There may be associated gastric atony.

Color. This varies with the type of secretory meal used. The admixture of bile, traumatic or partly-digested blood (as in cancer or ulcer) causes variations. In late stages of cancer "coffee-colored" contents are not infrequently removed, but diagnosis of cancer should never be deferred until such gastric contents are obtained.

Odor. Normal gastric extracts have a peculiarly bland odor. Iligh, free hydrochloric acidity imparts a characteristic sharp odor. In the majority of cases of benign retention (usually gastric or duodenal ulcer) the removed extracts have a yeasty odor. Where gastric stagnation is due to malignant disease a peculiar, rancid aroma ("old cheese" or cheap vinegar odor) is quite common. Sloughing gastric growths or fistulæ communicating with other viscera impart a penetrating "rotten" odor to extracts.

Chemical tests. If possible, gastric extracts should be filtered after thoroughly mixing with a glass rod. If only a few cubic centimeters of material are available tests for acidity may be made upon unfiltered extracts. The readings are usually higher than where filtered extracts have been used.

Estimation of acidity. 1. *Qualitative.*—Moisten a piece of pink Congo-paper with distilled water. Dip the wet end into the gastric extract (filtered or unfiltered). If free hydrochloric acid is present, the pink Congo-paper turns blue. The rapidity of the change and the intensity of the blue color constitute a rough index of the amount of free hydrochloric acid present. In the presence of much organic acid (lactic, acetic, butyric), the pink Congo-paper assumes a blue-gray shade.

If the Congo test is positive (blue color) to be sure that free hydrochloric acid is causing the change, Guenzburg's test may be made. Boas' modification is the best, because the Boas solution is more stable than the original fluid proposed by Guenzburg. The test solution has the following formula:

Resorcin—	5.1	cc.
Sacchari albi—	3.	cc.
Alcohol—dil. ad.	100	cc.

Method. From two to five drops of filtered gastric extract are intimately mixed with a like quantity of the test solution in a small porcelain dish. The dish is then slowly heated over a low Bunsen flame. If gastric acidity is due to free hydrochloric acid, a lively cherry-red or magenta color results.

Organic acids. Volatile, fatty acids—as acetic, butyric, etc., are readily demonstrated by heating two or three cc. of gastric filtrate in a small test tube over a low Bunsen flame. At the mouth of the tube a strip of moist blue litmus paper is placed. As the fluid in the test tube is brought to boiling point, the fatty acids if present, volatilize and their fumes color the blue litmus paper red.

Qualitative estimation of acidity. Toepfer's method answers all practical demands.

Solutions needed—(a)—A ½ per cent. alcoholic solution of dimethylamidoazobenzol. This is used to determine free hydrochloric acidity.

b.—A 1 per cent. alcoholic solution of phenolpthalein. This serves to indicate total acidity.

c.—A deci-normal solution of sodium hydroxide (Na OH). This should be, preferably, standardized by an expert chemist. Roughly, the solution is made by dissolving, with a *little* heat, four ounces (accurately weighed) of sodium hydroxide in 1000 cc. of distilled water. The solution should be kept in a bottle tightly closed with a rubber stopper. If evaporation is allowed to take place (as in a warm room), the solution is worthless for acidity estimations.

Method. A burette, graduated in tenths of a c.c. is partly filled with the tenth normal sodium hydroxide solution. While tests are being carried out, it is well to prevent alterations in the strength of the soda solution by covering the top of the burette with an inverted test-tube.

Ten cc. of the filtered gastric extract (preferred) are accurately measured into a porclean evaporating dish. This may be used to measure both free hydrochloric acidity and also total acidity. To it are added two drops of the dimethylamidoazobenzol solution. If free HCl is present a lively cherry-red color is taken by the gastric filtrate. If no free HCl is present, the filtrate remains uncolored or assumes a pale-yellow to orange tint. Next, one notes the exact level of the soda solution in the burette. It is well for the beginner to write down this figure. The soda solution is now allowed to fall, drop by drop, into the porcelain dish containing the gastric juice—dimethylamidoazobenzol mixture. As the free hydrochloric acid becomes neutralized by the soda the cherry-red color gradually disappears and a lemon-yellow tint is seen. It is well to keep the gastric extract stirred or shaken during this neutralization, so that a prompt admixture of soda solution with it takes place and one consequently does not over-neutralize the acid.

When the color change is complete (avoid excess of soda solution), note accurately the amount of soda solution which has been used in neutralizing the acid. This figure multiplied by ten (because we are working with ten cc. of juice on the basis of one hundred) gives us the degree of acidity.

Example—First burette reading 11.4
Second burette reading 13.6

2.2

2.2x10 equals 22 free HCl.

If five cc. of gastric juice only are available, the cubic centimeters of soda solution used must be multiplied by twenty. To obtain the per cent. of acidity multiply this by 0.00345.

Estimation of total acidity. For practical purposes, total acidity may be estimated from the same specimen used in test for free HCl.

Mix into the specimen (which now is of lemon-yellow or orange color) two or three drops of solution of phenolpthalein. This is the indicator. If total acidity is not in excess of the free hydrochloric acid, the solution in the porcelain evaporating dish will change from yellow to dark cherry-red. If total acidity is higher than the free HCl then no color change will occur until the existing acid has been neutralized by the tenth normal sodium hydrate solution from the burette. In the latter event titration is carried on as where free hydrochloric acid is being estimated. One should note the exact amount of soda solution used to change the yellow to cherry-red, and be careful not to add soda solution after the first uniform red color appears. If one allows this to happen, the readings will be too high. This is a common fault with beginners. The amount of soda solution is multiplied by ten, and this added to the figures returned from the estimation of free hydrochloric acid equals the total acidity. Thus:

Soda solution used in neutralizing free HCl 2.2, hence free HCl 22.0.

Soda solution used to neutralize acidity with phenolpthalein as per indicator 1.6, or 16.

Total acidity equals 22+16 or 38.

Estimation of combined acidity and acid salts is roughly determined by subtracting the figure representing degree of free HCl from that representing total acidity. Thus:

Total acidity	38
Free HCl	22
Combined acid and acid salts	16

Alizarin is sometimes used as an indicator for the more accurate estimation of "combined," or bound, hydrochloric acid. It is titrated in gastric juice with tenth normal soda as above. There is no great practical advantage in its use. Clinically, a high figure representing "combined" acidity is found in cases of gastric retention and particularly where this retention is of the malignant type.

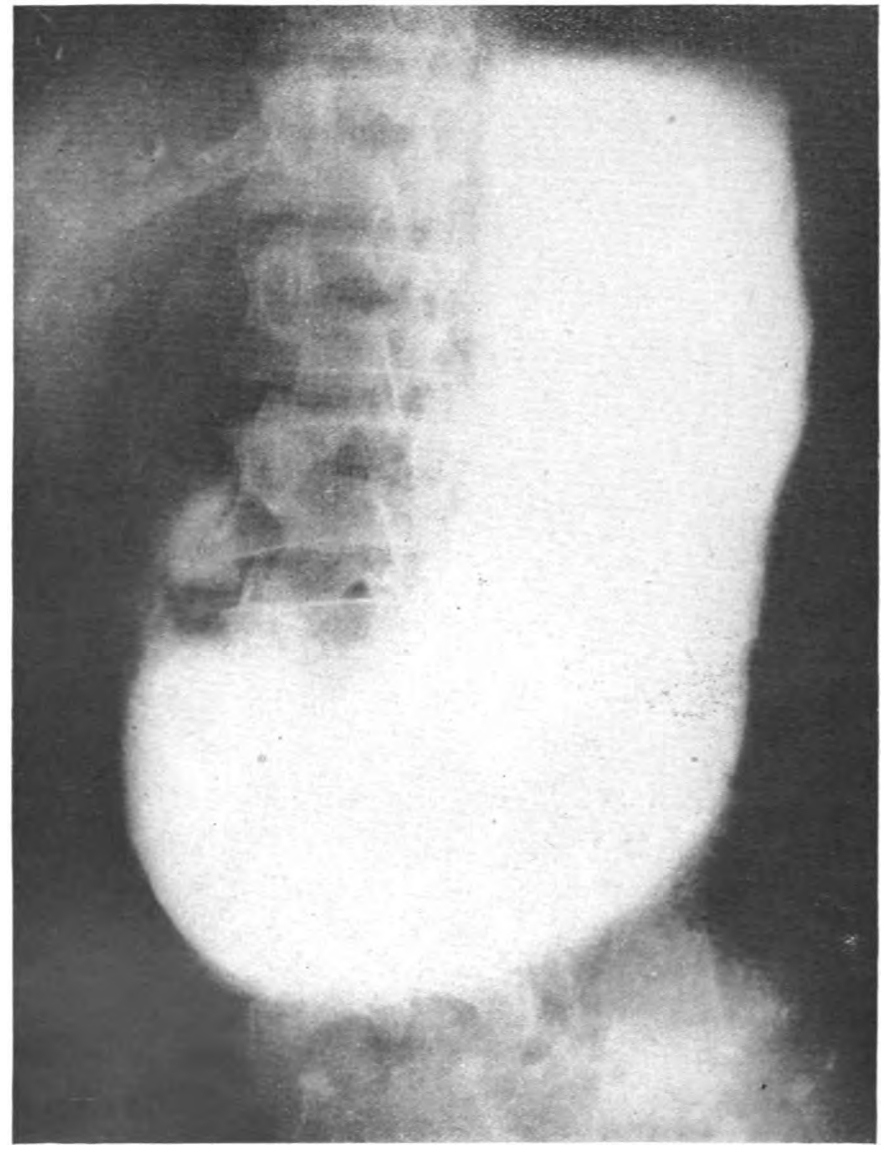
Tests for lactic acid. In a test tube add six drops of liquor ferri sesquichlorate to three drops of 95 per cent. carbolic acid. Shake gently. Add distilled water until the solution is amethyst-blue. Pour equal parts of this mixture into two test tubes. One is to be used as control. Next, drop by drop, pour into one of the test tubes the filtered gastric extract. If lactic acid is present the amethyst color is discharged and the contents of the tube assume a canary-yellow tint. This should be compared with the color in the control tube. Doubtful quantities of lactic acid have no clinical significance. Easily recognizable quantities of lactic acid are noted in late cancer quite uniformly. In rare instances of benign pyloric obstruction or gastric atony (particularly if the patient has been on milk or sour milk diet), lactic acid may be demonstrated.

Strauss has improved the above technique for testing for lactic acid by using the ether extract of the gastric filtrate.

Chemical test for altered blood ("occult blood") in gastric extracts or feces. Benzidin test—Solutions needed: (a) 1 per cent. alcoholic solution of chemically pure benzidin (pink powder) in 95 per cent. alcohol or strong acetic acid. (b) Pure ether. (c) Glacial acetic acid. (d) Strong solution of hydrogen peroxide.

Method. Three to five cc. of gastric extract (non-filtered) are placed in a test tube. To this are added five to ten drops of glacial acetic acid (to separate the hematin, forming an acid hematin). Mix thoroughly. Next add two to three cc. of ether and mix the contents of the tube by pouring from one test tube to another several times. Allow to stand now for several minutes until the clear ethereal extract floats above the semi-solid gastric contents. This ether extract contains the acid hematin, if any is present. Pour it off into a clean test tube. To this now add fifteen drops of the standard benzidin solution; mix. Next add one to three cc. of the peroxide of hydrogen solution. If blood is present the contents of the tube promptly take on a brilliant emerald-green hue. If much blood is present this rapidly changes over to a deep ultramarine. If the color change does not appear within one minute we consider that the amount of altered blood present has no clinical significance.

Feces are examined similarly to the gastric extract. The properly prepared stool only should be used. This is obtained by placing the patient on a meat- and meat-product-free diet for three days. On the day that the stool is to be obtained the patient takes no food other than milk and bread. The sec-

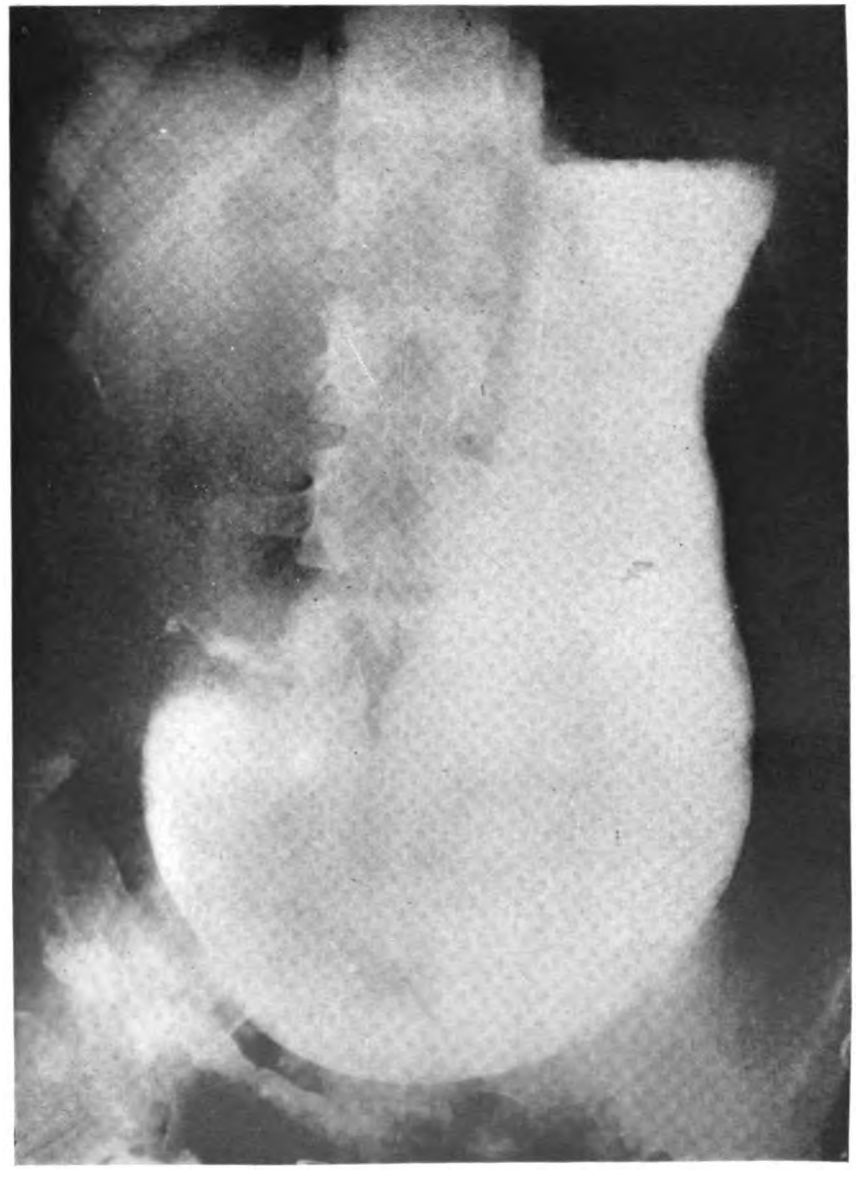


X-RAY PICTURE OF STOMACH.

Radiogram of stomach, showing carcinoma involving pylorus, antrum and greater curvature (A). Note obliteration of pylorus and antrum, irregular outline of greater curvature and absence of visualization of the duodenum.

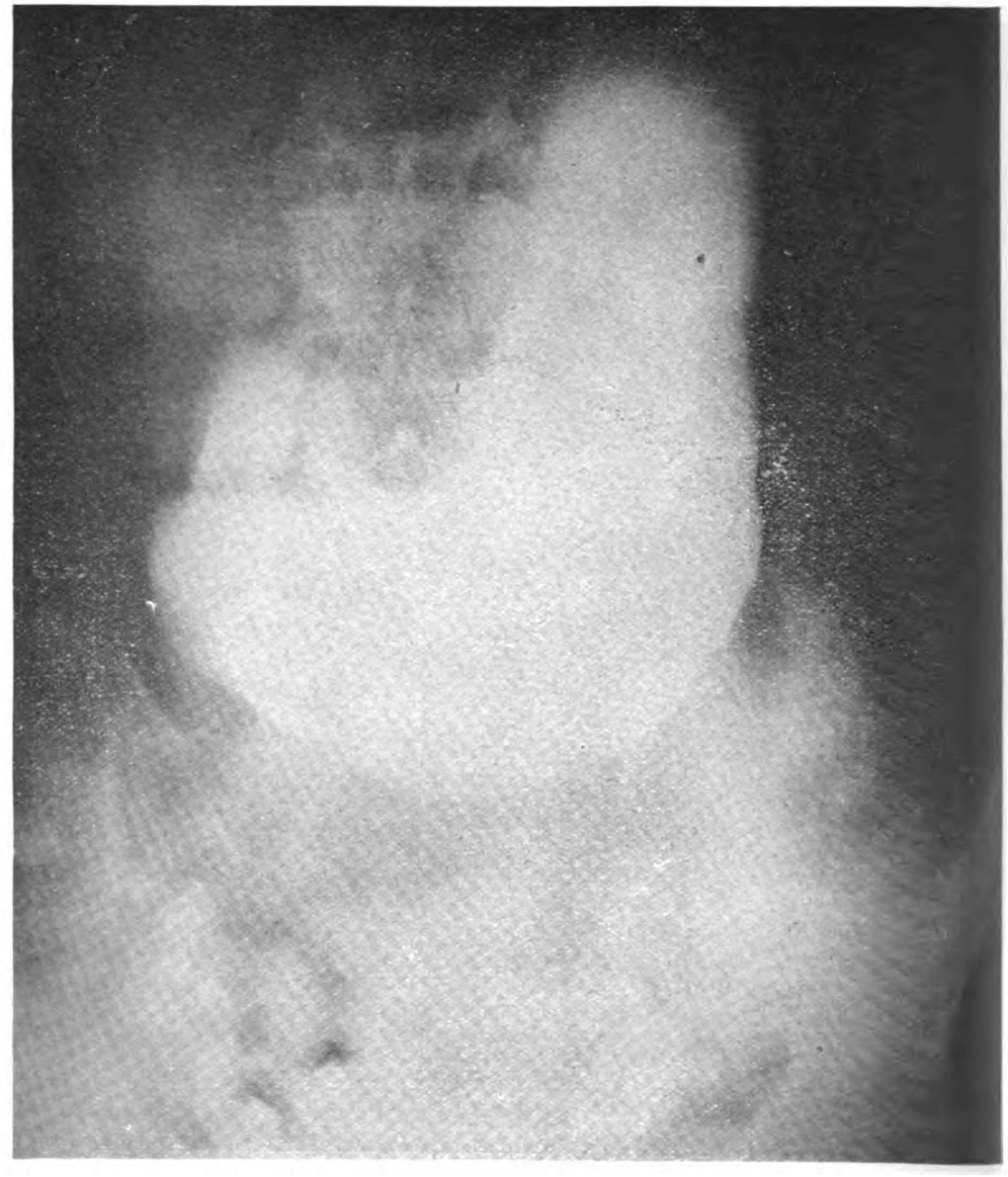
X-RAY OF THE PYLORUS.

Radiogram showing calloused ulcer at the pylorus and lesser curvature. Note irregular outline of lesser curvature (antral portion), and pylorus, with incomplete visualization of the bulbus duodeni.



X-RAY OF THE PYLORUS.

Radiogram showing perforating ulcer at pylorus. Note irregular pyloric end, with small, tent-like loculus on the pyloric portion of the lesser curvature.



X-Ray of Gastric Ulcer.

Radiogram showing chronic perforating ulcer of the lesser curvature, near the pylorus.

ond stool passed should be tested. A mild saline (as citrate of magnesia) may be used to secure free opening of the bowels.

One now proceeds exactly as in the method outlined above for testing gastric extracts. If the stool is hard and formed, it may be rendered semi-fluid by mixing with distilled water. The color changes after the addition of the peroxide of hydrogen correspond with those resulting when blood is present in gastric extracts.

Interpretations of the test for altered blood are entirely individual. One should be sure that the subject is not bleeding from mouth lesions (after tubing to obtain gastric extracts), hemorrhoids, fissures, etc. If these have been eliminated as sources of bleeding, then the chemical demonstration of blood means that there is a bleeding focus somewhere. It is the business of the physician to locate this. Bleeding of this type occurs intermittently in acute or chronic peptic ulcer, and usually continuously in fresh erosions, ulcera carcinomatosa and gastric cancer, cancer of the esophagus, or the large bowel.

Test for ferments—Pepsin—Mett's method. Thin-walled glass tubing having a calibre of 1.5 mm. is cleaned thoroughly and dried. It is then cut into convenient lengths, say ten cm. These are filled by suction with fresh white-of-egg which has been filtered through several layers of fine gauze. If the more solid parts of the albumin are taken up one can avoid air bubbles. As each tube is filled the ends are passed through a Bunsen flame and sealed. When the required number of tubes has been filled they are placed in a pan containing distilled water. They may be kept from the bottom of the pan by allowing them to rest on glass rods. The temperature of the water is slowly brought up to ninety-five degrees C. and this temperature is maintained until the albumin in the tubes is coagulated. This takes about five minutes. The tubes may be preserved in sixty-six per cent. watery solution of glycerin until needed. To make the test, take out one tube, cut about two cm. from it and wash in distilled water. Place this in a small bottle or test tube containing three to five cc. of filtered gastric extract; cork and place in an incubator for from ten to twenty-four hours. If pepsin is present in the presence of free HCl one notes disappearance or partial disappearance of the egg clot in the glass tube. This can be estimated as mm. of digestion. It is stated that normal peptic digestion is from 3.5 to 4.5 mm. in twenty-four hours. In subacidity and anacidity lower values are obtained, while in hyperacidity the peptic digestion is commonly increased.

A simpler, but less exact test, may be made by dropping a small disc (made with a cork-borer from a hard boiled egg) of egg-white into a test tube containing from three to five cc. of gastric filtrate. Place in an incubator at 37° C. for twenty-four hours. In the presence of free HCl, if pepsin is present, the egg-white disc becomes translucent at its edge. Roughly, the amount of pepsin can be gauged by noting the depth of this translucent area.

Test for rennin and its zymogen. One cubic centimeter of gastric filtrate is added to fifteen cc. of fresh, alkalinized milk in a test tube. This is placed in an incubator at 37 degrees C. If normal quantity of the ferment is present, coagulation will occur within fifteen to thirty minutes. If no hydrochloric acid is present in the gastric filtrate, add to the gastric juice-milk mixture five drops of a solution of calcium chloride. If rennin zymogen is present, the calcium salt converts it into rennin, which will then clot the milk.

Test for peptid splitting enzymes in gastric extracts. (Carcinoma test of Neubauer and Fischer). Smithies advises the following modification: The test is set up as follows: 1. Test-tubes of ten cc. capacity are employed. These should be carefully cleaned with boiling water and dried inside. They are numerically marked for identification with a wax pencil. Into each test-tube is carefully measured, by means of a sterile graduated pipette, 0.5 cc. of

the glycyltryptophan solution. (Closing the proximal end of the pipette with a finger allows the pointed distal end to pass through the toluol layer overlying the glycyltryptophan solution, and the dipeptid to be withdrawn with the minimum of contamination.) Five cc. of the recently secured, filtered gastric extract are then measured by a clean, graduated pipette and poured into the correspondingly numbered test tubes to which glycyltryptophan solution has been already added. Two control tubes are used. In one is placed 0.5 cc. of glycyltryptophan solution and 5 cc. of normal salt solution and into the other is placed 5 cc. of normal salt solution, with added glycyltryptophan solution. In the entire series, each tube next receives 0.5 cc. of toluol (Toluene, Merck). The contents of the tubes are then mixed by inverting several times. The tubes are next placed in a water-bath (an incubator may be used) at 37° C. for twenty-four hours.

2. At the expiration of the incubation period, the test tubes are removed from the water-bath. Clean test tubes of 10 cc. capacity and numbered to correspond with the gastric extracts tested, as well as the controls, are set in racks. Into each of these tubes is measured, by means of a graduated pipette, 5 cc. of the glycyltryptophan-gastric-extract mixture lying below the toluol in the recently incubated tubes. To each tube are then added three drops of a three per cent. glacial acetic acid in distilled water solution. The tubes are well shaken. Bromin vapor is allowed to flow into each tube, until it appears amber-yellow above the contained fluid. The tubes are again shaken. Examination by daylight (preferred) or by white, artificial light is now made for evidences of the characteristic rose-pink reaction between the amino-acid (tryptophan) and the bromin.

Tryptophan test. As suggested by Weinstein, this is made, as routine, on the fresh gastric extracts. Inasmuch as, occasionally, swallowed saliva, amino-acids, regurgitated duodenal contents and the like may give the bromin vapor reaction, before incubation or without the addition of a dipeptid such as glycyltryptophan. Five cc. of each fresh, filtered gastric extract is poured into test-tubes of ten cc. capacity, acidulated with the three per cent. acetic acid solution and treated with bromin vapor as above. If no characteristic rose-pink color results the tubes are incubated with the corresponding specimens that have been mixed with glycyltryptophan solution. For accurate work, it has seemed best to us to cover these "tryptophan test" contents with a layer of toluol. At the end of twelve, twenty-four and forty-eight hours, note is made of changes in color, and these results are compared with those obtained with the preparations in the first series.

Wolff-Junghan's test for soluble albumin (used to differentiate malignant from benign achylias). Smithies advises the following manner of performing this test: The day previous to the examination of his gastric extract the patient is given one ounce of castor oil at 4 P. M. This is followed at 6 P. M. by a motor test-meal consisting of mixed food. At 7 P. M. twenty raw, seedless raisins are given. Twelve hours later (7 A. M. the following morning) the patient is fed sixty grams of second-day bread and two hundred cc. of water. This secretory test-meal is removed from fifty to sixty minutes after administering. The specimen secured is thoroughly mixed, filtered through double hydrochloric-acid-washed papers, and tested for dissolved albumin within an hour of its being obtained from the stomach. On account of the fact that, as has been shown, but 52.2 per cent. of cases of gastric cancer yield gastric extracts revealing absence of free hydrochloric acid, and that in 15.7 per cent of cases, free hydrochloric acid ranges between twenty and fifty per cent. we have deemed it advisable to apply the test for soluble albumin not only to achylias, but also to gastric extracts where the free hydrochloric acid was below twenty per cent. In a few instances of suspected malignant ulcer we

have performed the test upon gastric extracts with higher free hydrochloric acid content. In such we have been fully alive to the possibilities of error, but for the purpose of gaining information and for comparison we have deemed it wise to make the test.

Procedure. Six absolutely clean test-tubes are required for each test. Those of the narrow type and of twenty cc. capacity answer very well. The tubes are numbered serially from one to six. They receive respectively one cc., 0.5 cc., 0.06 cc. and 0.025 cc. of the filtered gastric extract. These amounts are readily measured by means of a one cc. pipette, graduated in 1 1/100 cc. By means of a 10 cc. pipette, graduated into 1 1/100 cc., the volume in each test-tube is next consecutively brought up to ten cc. volume with distilled water. This gives from the tubes one to six dilutions of gastric juice varying, respectively, from 1 to 10 to 1 to 400 (viz., 1 to 10, 1 to 20, 1 to 40, 1 to 100, 1 to 200, and 1 to 400). These figures we have termed "units" of precipitable albumin. The tubes are then inverted several times to insure complete mixture of their contents. One cc. of the reagent to precipitate the albumin in solution is then carefully layered upon the contents of each tube. The precipitating reagent suggested by Wolff has proved satisfactory with us. It has the following formula:

Phosphotungstic acid (puriss)	3 cc.
Hydrochloric acid (concentrated)	10 cc.
Alcohol (96 per cent.)	200 cc.
Aq. dest. q.s.a.d.	2000 cc.

Mix and keep in a glass or rubber-stopped flask in a cool place.

Manifestation and interpretation of the test. If there has been dissolved albumen in any of the tubes, the juncture of the Wolff reagent with the diluted gastric extracts is marked by a pearly-white zone or "ring." This is better brought out if the tubes are inspected against a black background. (We have used a piece of black cloth such as photographers employ when focussing cameras.) The tubes should be inspected at once after adding the Wolff solution. Prolonged standing allows cloudy zones to form which render comparative interpretation dubious.

We have interpreted our results after Wolff and Junghans' suggestion thus: If the white ring of precipitated albumin appears in tubes 1, 2 and 3 (namely, units of albumin from 10 up to 50) and no further manifestations are present in the remaining three tubes, we have called the test negative. If tubes 1, 2, 3, and 4 exhibit rings (units of albumin from 10 to 100) we have considered the reaction doubtful. The presence of white rings in tubes 1, 2, 3, 4, 5 and above (units of albumin ranging from 10 to 200 to 400) we have taken to denote a positive test.

Clinical value. 1. When carefully performed and interpreted the Wolff-Junghans test for demonstration of dissolved albumin in gastric extracts was positive or suspicious in eighty per cent. of our series of gastric cancer. In this series it was a more constant finding in gastric extracts than were absent free hydrochloric acid, the presence of lactic acid, and the glycyltryptophan test. It was rather more constant than tests for occult blood and the demonstration of gastric motor inefficiency. It was not so consistent in its manifestation as the demonstration of organisms of the Boas-Oppler group or the increase in the formol index.

2. In extragastric malignancy, gastric syphilis, and nephritis the Wolff-Junghans test is inconstant.

3. In the differentiation between malignant and non-malignant achylias the Wolff-Junghans test, when interpreted in connection with other clinical and laboratory data, is of considerable value. Positive reactions are rarely

obtained in the achylias of primary anemia, simple achylia gastrica, and simple achlorhydrias when such are unassociated with gastric motor inefficiency.

4. Simple gastric and duodenal ulcers, especially when accompanied by pyloric stenosis or gastric atony, may give confusing responses to the Wolff-Junghans test.

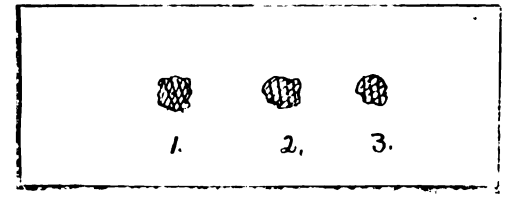
5. The presence of blood in gastric extracts may be a factor in the production of certain atypical positive tests.

Test for bile. Fuming nitric acid is prepared by gently beating a few bits of match-wood in concentrated nitric acid. A large drop of gastric juice is placed on a sheet of filter paper. A similar drop of the fuming nitric acid is placed on the same filter paper in such manner that its "spread" meets that of the gastric juice. If bile be present a rainbow-like play of colors appears at the junction zone of the two drops.

Floating nitric acid upon two or three cc. of gastric juice in a small porcelain evaporating disk likewise serves to demonstrate the play of colors if bile be present.

Microscopic examination of gastric extracts. The unfiltered extracts are used. A rapid method is to place three small drops of the removed contents about one cm. apart upon a glass slide thus:

To drop 2 is added one small drop of normal iodine solution (starch stain) or of Lugol's fluid; to drop 3 one small drop of osmic acid (fat stain);



drop 1 is left unstained. Cover slips are now pressed down firmly upon the drops. The specimens should be examined with the oil immersion (preferred) on the 1/6 objectives.

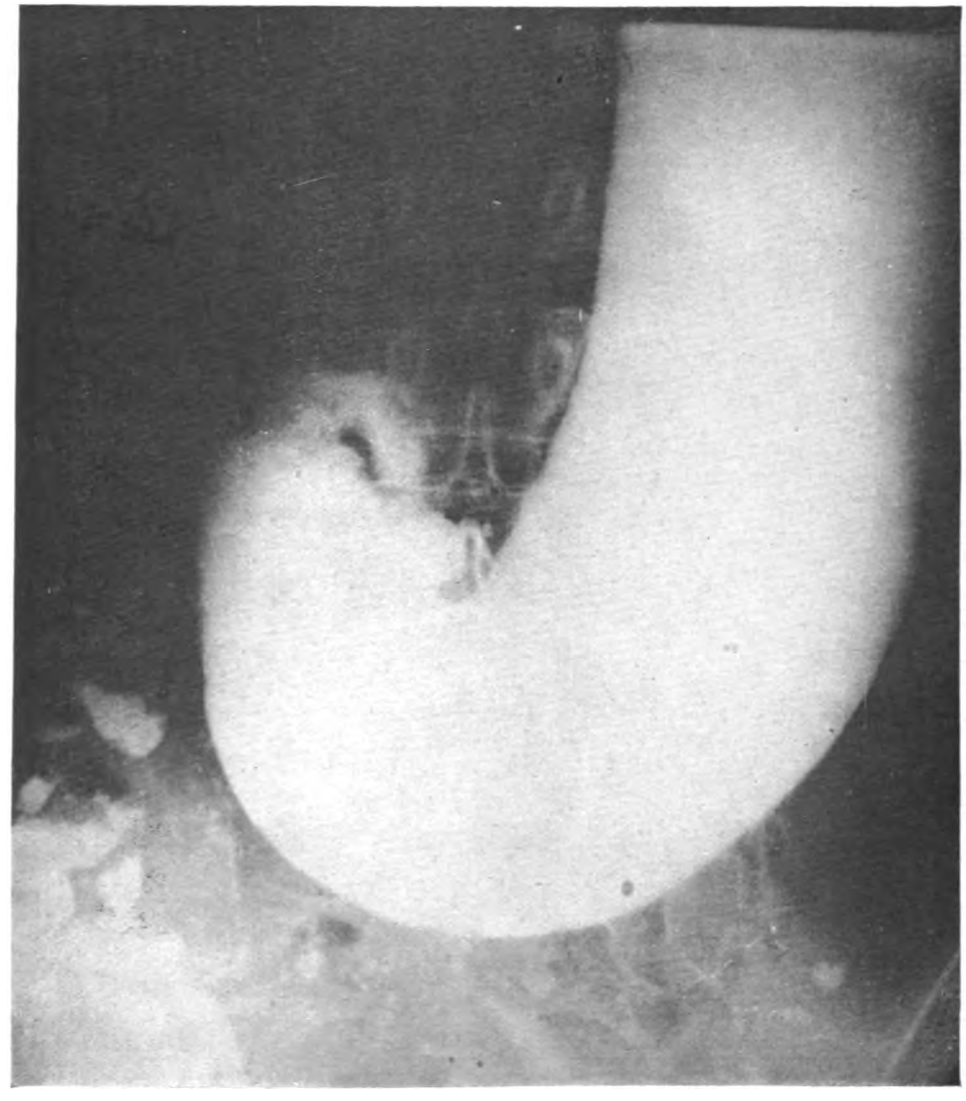
Better preparations are made by making thin smears of unfiltered gastric extracts upon cover slips, after the manner of making blood-smears. These are dried by rapidly passing through a Bunsen flame. They may then be stained with Unna's polychrome methylene-blue, or, if many specimens are to be quickly examined, by color-agar method devised by Smithies.

Interpretation. Smithies states that after the examination of 7,041 cases, starch digestion is not a constant index of the acidity of the stomach juice. Diastatic action of saliva depends more on motor conditions than upon secretory. The character of the ingested food is a modifying factor. In some instances of low gastric acidity, with normal motility, it would seem that an anti-diastase were present in gastric extracts.

Microscopic remnants of the motor meal have no diagnostic significance other than that indicated when found in association with food microscopically.

The diagnostic significance of the micro-organisms in gastric extracts. From our studies we have developed four microscopic pictures which seem almost pathognomonic for certain types of disease. Apart from these we can see nothing very significant. Certainly high gastric acidity by no means insures bacteriologic cleanliness.

Complex 1; that of *benign gastric retention* (usually ulcer). In 89 per cent of our cases of this type, the presence of large numbers of actively budding yeast, associated with large and small sarcinæ and bacilli, apparently of the



X-RAY OF DILATED STOMACH.

Radiogram showing greatly dilated stomach, gastric, atony, chronic ulcer on the lesser curvature near the pylorus and dilated duodenum.

X-RAY OF DILATED STOMACH.

Radiogram showing dilatation of the stomach, active pyloric peristalsis, ulcer of the duodenum adherent to the lesser curvature near the pylorus.

X-RAY OF "STEER-HORN" STOMACH.

Radiogram showing large steer-horn stomach pulled over to the right and held there by adhesions from the gall bladder to the duodenum and pylorus. Moderate pyloric obstruction.

X-RAY OF "HOUR-GLASS" CONTRACTION OF STOMACH.

Radiogram of stomach showing hour-glass contraction due to saddle, calloused ulcer (pars media).

colon group, and food bits were demonstrated. The gastric acidity was generally above 50.

Complex 2; that of gastric cancer. In 93.8 per cent. of all our proved late malignant cases, organisms of the Boas-Oppler group, associated with food retention, and acid averaging below 10, was a characteristic picture. In but 30 per cent. of instances were budding yeasts concomitant. In but 10 per cent. were sarcinæ associated. Threads of streptococci were found in 6.2 per cent. and these usually in the non-retention group. There is no characteristic microscopic picture of early gastric cancer, other than that associated with gastric ulcer of the retention type. In less than 1 per cent. of our cases of gastric cancer were we able to demonstrate so-called "cancer cells" with active mitoses. These were all late cases or cases where the cardiac orifice was involved with a sloughing growth. In this class of cases a diagnosis can, of course, be made from the history and physical examination.

Complex 3; achylia gastrica—primary or secondary. In gastric extracts of low or absent hydrochloric acid, where there is atrophy of the mucosa and where motility is not interfered with, there are found long chains of streptococci (resembling beads of a rosary); groups of large, deep-staining cocci, and a peculiar, short, fat, acid-fast rod or cocco-bacillus that grows in short chains, pairs or alone.

Complex 4; where *perforation* into an adjacent viscus has taken place in malignant ulcer or primary cancer, or where obstruction has occurred below the duodenum, the picture of immense numbers of thick cocco-bacilli, with or without spirillæ or streptococci, in association with low acidity, retarded food progress and putrefaction as evidenced by the odor, is shown in more than 94 per cent. of instances.

Examination of feces. Much can be learned by examination of the stool, passed without catharsis. One should, however, know approximately upon what diet the patient is subsisting. The stool is generally greater in amount upon a carbohydrate than upon a proteid diet. More than 250 grains is considered an abnormal amount for a healthy individual to pass at one time.

Normal stools are usually cylindrical and firm, but for a given individual a mushy stool may not be abnormal; small, hard, round scybalous masses generally indicate that the stool has been delayed in the large bowel. Quantity of stool is often greatly increased in pancreatic insufficiency. Diarrheic stools are not uncommon in achylia gastrica, pernicious anemia, gastric cancer, pancreatic disease, protozoic colitis, acute inflammation of the gastro-intestinal tract, at the onset of acute infectious diseases (la grippe)—metallic poisoning, dietetic errors, etc. Nervous individuals may have periodic diarrhea at times of menstruation or during psychic strain.

Color. This varies much according to diet. When the patient is upon normal diet, light-yellow stools are associated with deficient production of bile or interference with its free passage into the bowel; large, bright colored, greasy stools, intermixed with chunks of undigested food or gobs of unbroken-up fat (resembling butter or egg yolk) are common in chronic pancreatic disease; tar-colored or brownish-black stools (provided no medicine such as bismuth, iron, etc., is being taken) generally mean partly digested blood; frank hemorrhage colors stools red; green stools may occur from excessive use of calomel, over-production of bile, diet (spinach, green beans, etc.), or growth of a chlorophyllaceous mould; stools of various color may result from internal administration of carmine, santonin, rhubarb, charcoal, senna, hematoxylin, etc.

Rice-water stools (cholera) "pea-soup" stools (typhoid) or mucilaginous stools (catarrhal states of the large bowel), are fairly pathognomonic of the diseases with which they are associated.

Odor. Skatol and indol impart disagreeable odors to normal stools. Special foods, fermentation, sloughing tissue or administered medicines may characteristically change this odor.

Gall-stones are rarely found in stools. In suspected cases washing the stool with water as it lies on a thin-meshed sieve may enable one to recover stones. Lumps of oil, soap and the like, are frequently mistaken for gall-stones.

Pus generally comes from abscess cavities discharging into the bowel. Dysentery or tuberculosis should be suspected.

Chemical test of feces. Blood. This has already been described under gastric examination.

Acidity. Kaplan suggests rubbing up five grams of feces in thirty cc. of distilled water. Into a small porcelain evaporating dish pour two cc. of the resultant emulsion. Add three drops of 1 per cent. alcoholic solution of phenolphthalein as an indicator. Now titrate to a pink color with tenth normal sodium hydroxide solution and estimate acidity as in the case of gastric juice. A normal stool after a Schmidt test diet requires about one and five tenths cc. of tenth normal sodium hydrate solution to neutralize two cc. of stool emulsion. In fermentation, this acidity may be increased or diminished.

Schmidt test diet. Morning, 8 A. M. ½ litre (500 cc.) raw milk (or if milk disagrees, ½ litre cocoa made from 400 cc. water, 100 cc. milk, 20 grams cocoa powder and 10 grams sugar).

Forenoon, 10 A. M. ½ litre oatmeal gruel (40 grams oatmeal, 10 grams butter, 200 cc. milk, 300 cc. water and 1 egg strained).

Noon, 12:00. 125 grams chopped beef (raw weight), broiled rare with 20 grams butter, 250 grams potato broth (made of 190 grams mashed potato, 100 cc. milk and 10 grams butter).

Mid-afternoon, 3 P. M. Same as morning.

Evening, 6 P. M. Same as forenoon.

This should be used in all cases where accurate observation of the digestive ability of the pancreas is desired.

Test for bile pigments. (Schmidt.)—Light-colored stools do not necessarily mean that bile ducts are obstructed or that liver function is absent. Diet or failure of fat digestion may closely simulate alcoholic stools. To determine the presence or absence of bile pigment, grind up five grams (five cc. in case of a fluid stool) with twenty cc. of saturated solution of bichloride of mercury in distilled water. Allow to stand a few minutes. Pour off the supernatant fluid into a Petrie dish and cover. Place the dish upon a sheet of white filter paper. If bile-pigments are present, within twelve hours the fluid in the Petrie dish will assume a greenish (biliverdin) or pink (bilirubin) hue. This is a very reliable and rapid routine test.

Tests for pancreatic function. (Gross—Fuld—Wohlgemuth.)—This test has for its object the demonstration, quantitatively, of the presence or absence of the pancreatic ferments, trypsin (proteid-cleaving) and amylopsin (carbohydrate-cleaving). It has certain limitations, but is the most dependable clinical test that we at present have for obtaining information respecting the enzyme power of the pancreas.

Test for pancreatic ferments. First the patient should be put upon Schmidt test-diet for twenty-four hours. To obtain a stool for ferment examination, calomel two to three grains, or phenolphthalein-five grains, is to be preferred to salts. At bed-time collect the second stool passed. The Fuld Gross-Wohlgemuth test uses for trypsin testing a solution of casein, ten grams, sodium carbonate, ten grams; chloroform, ten cc. to one litre of water. If the stool is not very liquid five grams of feces are rubbed up with twenty cc. salt solution and filtered. Dilutions of 1 to 10, 1 to 100 and 1 to 1000 are made and five-tenths and one cc. and two cc. of these dilutions added to nine test

tubes each containing five cc. of the casein solution. The tubes are incubated for twenty-four hours at thirty-eight degrees C. and completion of the digestion tested by adding five per cent. acetic acid, which should not cause a precipitate in tubes in which digestion is complete.

The estimation is made by units, one unit being the digestive power of one cc. of feces filtrate to digest one cc. of casein solution. If 1 cc. of the 1 to 1000 feces dilution digested 5 cc. of casein solution it would represent 5000 units. If 1 cc. of 1 to 10 dilution it would be 50. As there are 5 cc. of the casein solution we multiply the dilution of feces by 5 for 1 cc. or by 10 if we had only 0.5 cc. of feces dilution in the tube tested.

For amylopsin a similar technic is followed, using a 1 per cent. solution of soluble starch instead of the 1 per cent. casein or Lugol's solution. The end reaction is tested by adding 1 drop of 1/10 iodine solution to each of the starch tubes and feces dilution after twenty-four hours of incubation. The absence of a blue color shows completion of starch digestion.

The normal ferment content of the feces rarely falls below 200 units and may be as high as 10,000. Cases showing a ferment value of only 25 to 50 units are very suspicious as regards pancreatic disease.

Gastric ulcer—Diagnosis. I.—Facts determined from history.

(a)—Frequently, dietetic or hygienic irregularities. Males are more frequently affected than are females.

(b)—History of recurring acute infections. (La grippe—tonsilitis, exanthemata, etc.). Seasonal relation of distress not uncommon, exacerbations occurring in fall or spring.

(c)—Association with disease of appendix or gall-bladder (with which ulcer, especially in subjects below age of thirty, is often confused).

(d)—Periodicity of complaint occurs in from 75 to 85 per cent. until complications set in. Between "spells" or attacks of indigestion, so-called, there is generally good gastric health. Weight is not infrequently lost during attacks and rapidly gained when such cease.

(e)—*Epigastric distress* present in more than 95 per cent. Varies in severity from discomfort to severe, gnawing or cramp-like pains. Discomfort has point of maximum location, subjectively, in practically three out of four cases. Pain has usually reached its height within four hours following meals. Pain comes on sooner *post cibo* in ulcers located near the cardia than where such are well towards the pylorus.

(f)—*Food relief of distress* occurs in four out of five instances of peptic ulcer of the uncomplicated type. Relief of pain frequently bears relation to amount of food taken, i. e., a large meal gives longer relief than a small one. Pain is also relieved by vomiting, the taking of alkalies, by rest, diet and opiates.

(g)—*Vomiting* occurs in more than two-thirds of instances; vomitus usually comes on at the height of gastric distress and when acidity is highest. Vomitus of food that has lain in the stomach longer than six hours ("delayed vomit") increases as complications (stenoses or perforation) develop. Pyrosis, water-brash, eructations and sour belching are common on ordinary diet.

(h)—*Hemorrhage* (hematemesis or melena) occurs in from 30 to 40 per cent. of instances. While hematemesis is more frequent than melena, yet melena alone may occur wholly irrespective of the location of the gastric ulcer. Severe hemorrhage is accompanied by signs of shock and collapse.

II.—**Facts elicited upon examination.**

(a)—*Patient usually well nourished* without toxic or cachectic appearance, unless pyloric stenosis or "hour-glass" contraction have occurred.

(b)—*Average hemoglobin* about 80 per cent. unless severe hemorrhage has recently taken place.

(c)—*Area of epigastric tenderness* in region of pyloric half of stomach. This is usually in the mid-epigastrium but not necessarily so. The area is most frequently definitely local where acute or chronic perforation has taken place. A tender ridge may sometimes be palpated where a large chronic ulcer exists.

(d)—*Dilated, splashy stomach* occurs where marked pylorospasm exists or stenosis has taken place. If this is excessive, visible peristalsis (and rarely, "reverse" peristalsis) may be noted.

III.—**Facts elicited by laboratory examination.**

(a)—*Test-meal*—Motility interfered with in more than 50 per cent. of instances. *Gastric acidity* increased with regard to free hydrochloric acid in the majority of non-stenosing ulcers. In stenosing ulcers, with dilatation of the stomach, while free hydrochloric acidity may not be above normal, the total acidity is increased in greater ratio. Blood may or may not be present in gastric extracts (macroscopically or by chemical test). Lactic acid is a rare finding. Pepsin and rennin are frequently increased.

Microscopically where gastric dilatation has occurred, fermentative changes are proved by the finding of great numbers of budding yeasts and of sarcinæ (large and small types) together with remnants of retained food.

(b)—*Stool* may show nothing pathologic. Recent hemorrhages generally result in the passage of "tarry" stools for several succeeding days. Perforation of an ulcer to the pancreas not infrequently results in pancreatic inefficiency with passage of stools containing undigested food.

During periods of the ulcer's activity, if the patient is kept upon meat-free or milk diet for several days, at the end of such time the stool may be shown by chemical tests (benzidin or guaiac) to contain blood. Progressive ulcers or ulcers undergoing cancerous change generally show blood constantly in the stools by chemic tests.

(c)—*X-ray findings.* In many instances of uncomplicated ulcer no facts are returned after most careful examination by both fluoroscopic or plate methods. Complicated ulcers (stenosing, calloused, "hour-glass" producing, perforating, etc.), are recognizable in nearly three out of four instances by the combined screen and plate methods.

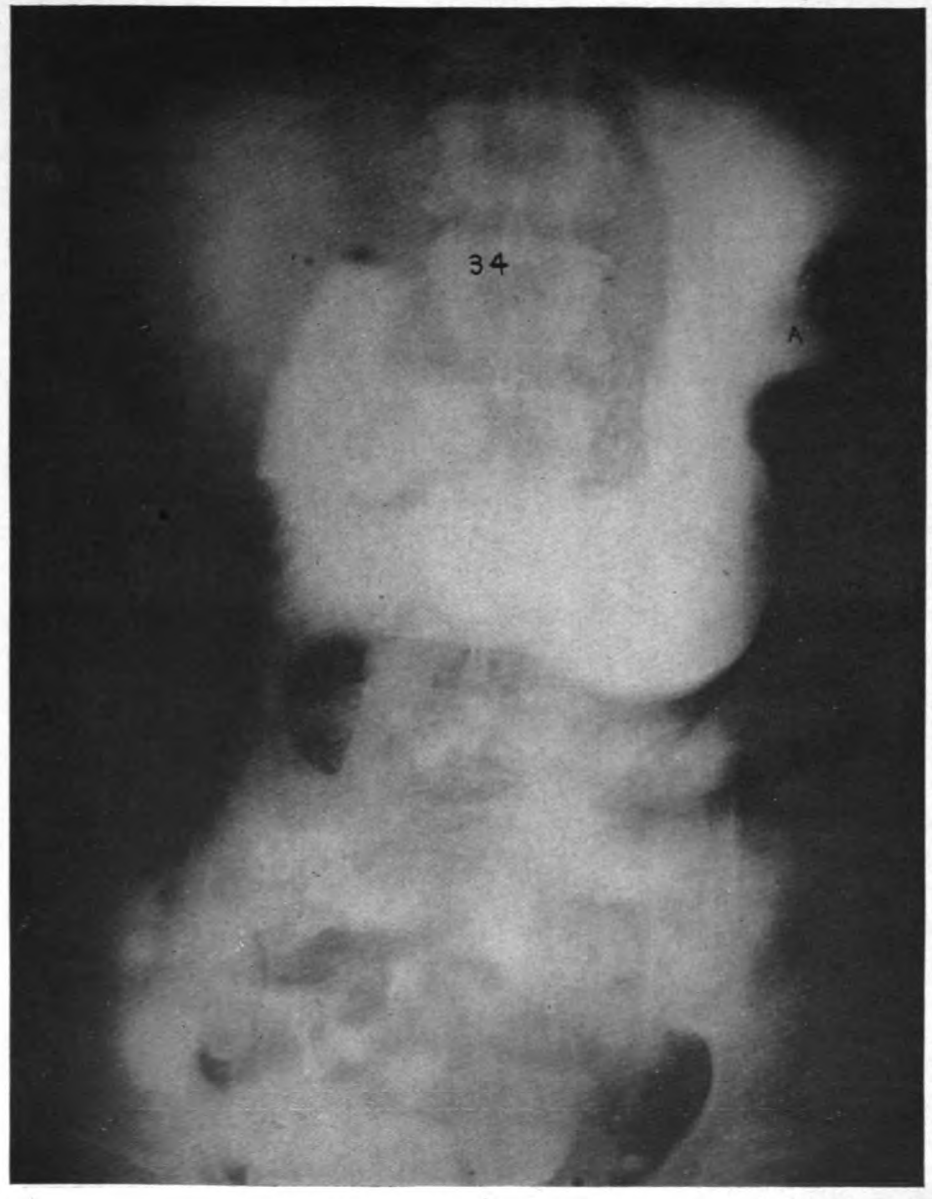
A dependable clinical technique is as follows:

Empty the gastro-intestinal canal by the administration of two ounces of castor oil in beer or malt extract.

Give a motor opaque meal, consisting of two to four ounces of barium sulphate (pure) or of bismuth subcarbonate in eight to ten ounces of cream of wheat, oatmeal, wheatena or the like at 4 A. M.

Six hours following examine by means of the fluoroscopic screen to locate the position of the motor meal. The presence of the opaque mixture in the stomach usually indicates anatomic interference with the onward progress of the food or furnishes evidence of gastric atony. Plates may be made at this time for purposes of recording the position of the motor meal.

A second meal for purposes of studying gastro-duodenal contour and

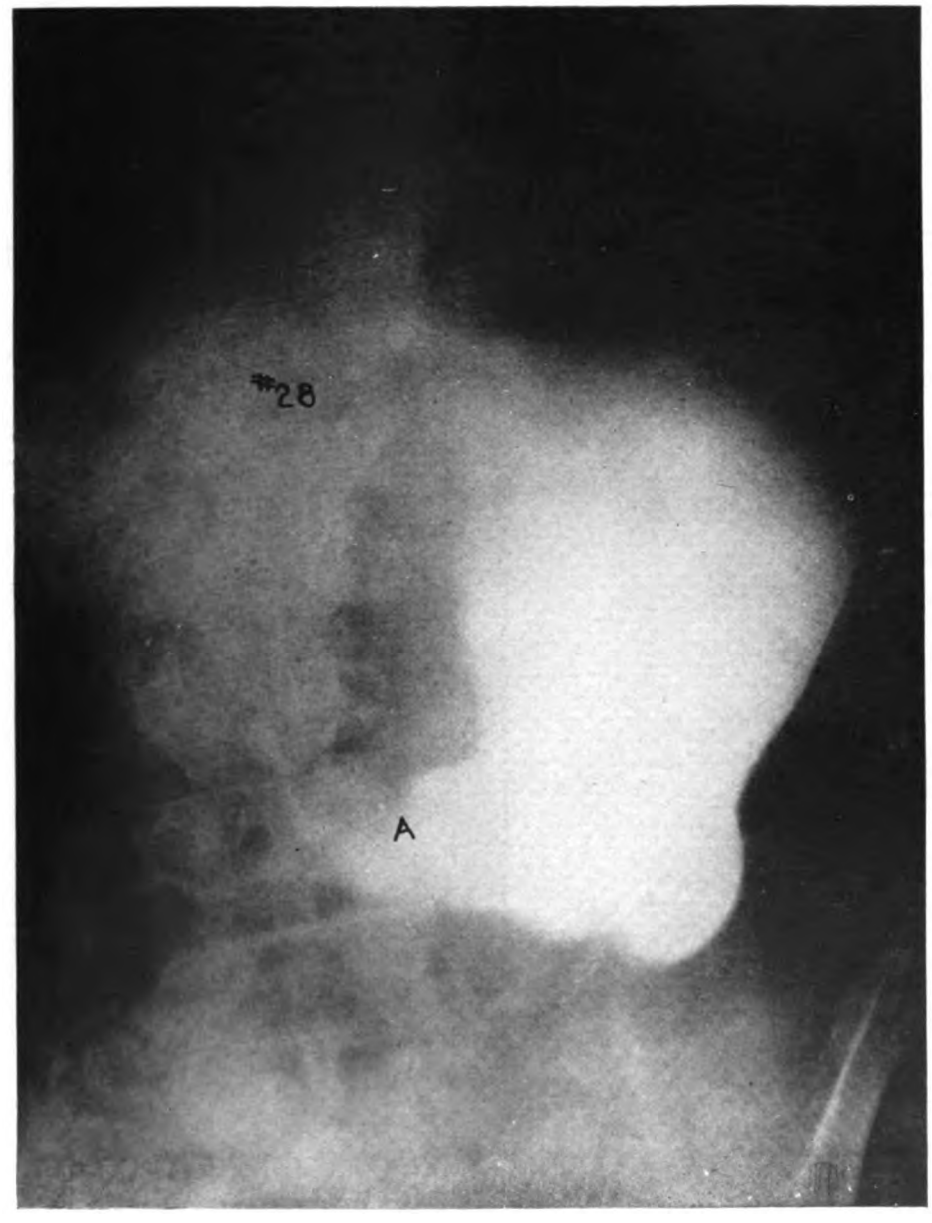


X-Ray of Gastric Ulcer.

Radiogram showing chronic perforating gastric ulcer (A) with bismuth in crater. Base of ulcer was adherent to the spleen; ulcer was malignant.

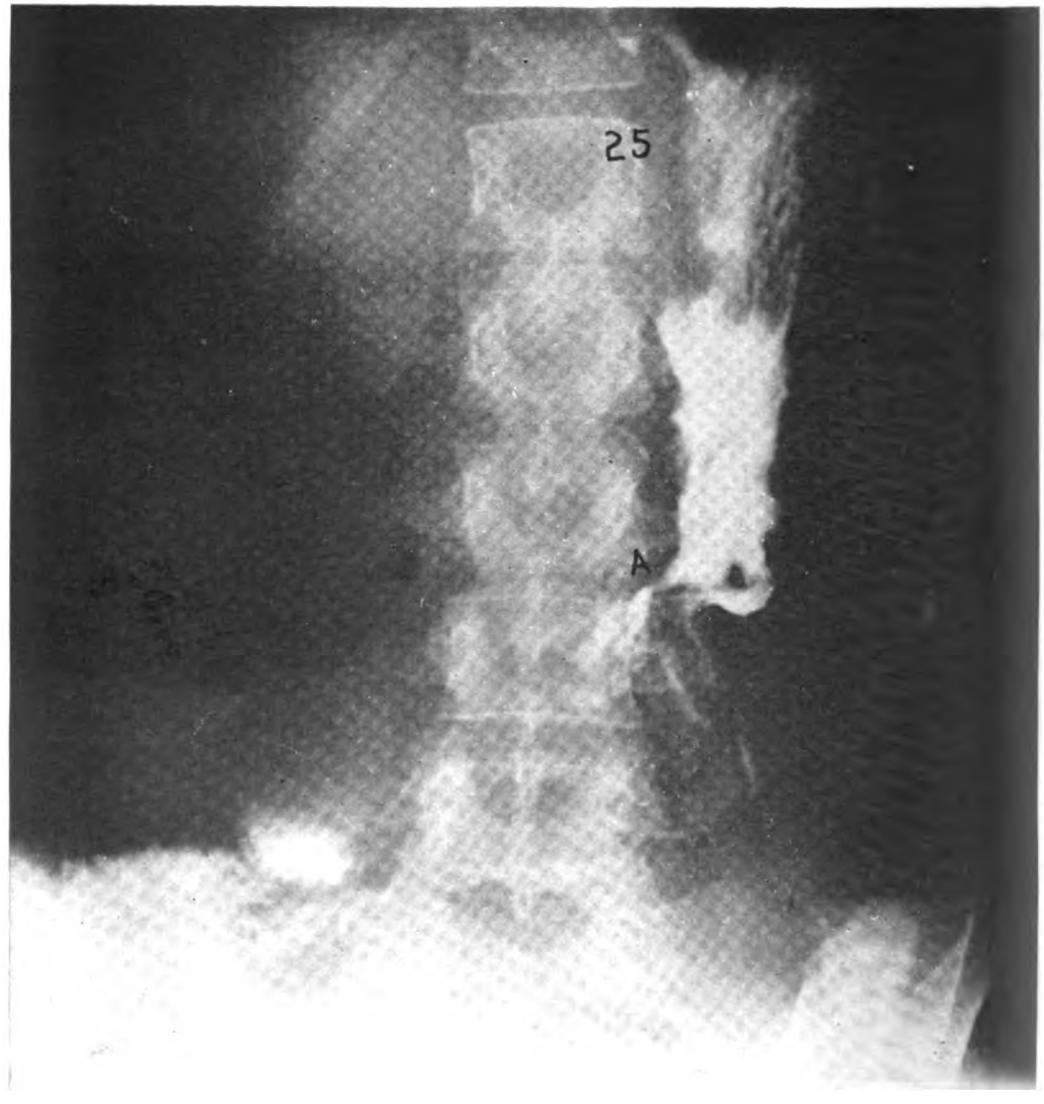
X-RAY OF STOMACH AFTER GASTRO-ENTEROSTOMY.

Radiogram of stomach showing patent gastro-enterostomy opening (greater curve) and closed pylorus.



X-RAY OF GASTRIC ULCER.

Radiogram showing perforating ulcer on the lesser curvature near the pylorus.



X-RAY OF STOMACH CANCER.

Radiogram showing extensive involvement of the stomach with cancer. Note small gastric lumen, irregular outline and malignant "hour-glass" stenosis at A.

activity is next given. This consists of two to four ounces of barium sulphate or of bismuth subcarbonate in sixteen to twenty-four ounces of buttermilk, fermalac or potato purée.

While the patient is taking this second meal, the stomach is observed by means of the fluoroscope. Palpation is carried on and the patient examined in various positions. If suspicious contractures, peristaltic waves or other abnormalities appear, the patient should be re-examined on several successive days, before and after the administration of such anti-spasmodics as atropin (gr. 1/50 per hypo.) or tr. of belladonna (gtt. no. xv.—every three hours for a day). This procedure aids in demonstrating the constancy or the transience of a local sign. Plates (frequently taken with the patient in different positions) may be next made for purposes of leisurely studying or for permanent record of positive or negative results.

In brief the **X-ray findings in gastric ulcer** are: (1)—*Positive signs.* (a)—The "niche" or "accessory cavity," indicating calloused, penetrating ulcer.

(2)—*Corroborative signs.* (a) "Incisura," i. e., local evidence of halting of peristaltic rhythm by spastic contraction of circular muscle fibres in the vicinity of an ulcer. Best brought out on screen examination during or after palpation. (b)—"Hour-glass" stomach. (Bi-loculation). This may be permanent (callous ulcer, perforation, adhesion) or transient (local spasm, with or without ulcer); it should always be proved by repeated examination with and without an antispasmodic (atropine, belladonna). (c)—Gastric residue. This may vary in amount. Its constant demonstration after six hours means atony or stenosis. Intermittently it may result from extra-gastric or gastric pathology causing pyloric spasm. (d)—Fixation of all or part of the stomach (perforation, adhesion-fistula). (e)—Area of tenderness to palpation, usually localized at some part of the stomach shadow. Should always be checked by repeated examination before and after an anti-spasmodic. (f)—Alterations in gastric peristalsis, e.g., exaggerated peristalsis, intermittent, frequently associated with spasmodic closure and relaxation of the pylorus. Antiperistalsis may be seen on rare occasions.

The interesting and valuable work by Cannon during the past ten years should be studied by every surgeon to obtain a correct idea of the mechanics of digestion.

It is only by a just comprehension of the physiological processes of the entire act of food digestion that one can safely undertake operative interference therewith.

It is plain that this normal arrangement must be of great value and that any surgical operation which interferes with any portion of this machine must leave the digestive apparatus seriously reduced in efficiency when compared with the normal. From this fact it is but logical to conclude that in any case of ulcer of the stomach or duodenum the patient's digestive apparatus will be in a vastly better condition to perform its physiological functions if it can be restored to normal without surgical interference. In the early stages of gastric or duodenal ulcers, experience has shown that this is possible in a large majority of cases if dietetic, hygienic and medicinal methods are carefully and persistently employed. Experience has also shown that many of these cases do not remain permanently cured but that they suffer from relapses usually more severe than the primary attack, and that after several of these "cures" and subsequent relapses many ultimately are compelled to seek relief by surgical operations. This may be explained by the theory that they were only apparently and not really cured, or that they were really cured and that later the same conditions which originally caused the ulcer to appear have given rise to the recurrence.

A careful study of the history usually brings out the fact that these patients

have subjected their stomachs to dietetic abuses, that they have lived under bad hygienic conditions as regards work, rest and regular habits of life, and that they have not given proper attention to their general health, and, as Futterer claims, become anemic as a result of these abuses.

On the other hand, with continued control of the hygienic and dietetic influences by a physician for a long period of time, it is commonly possible to train the patient so that he will acquire such habits of diet and hygiene as will prevent the recurrence of an ulcer after it has once healed.

These injunctions are less burdensome to the patient when he knows that even after operative treatment he would still be compelled to observe more or less rigid precautions.

ACUTE ULCER OF THE STOMACH

In acute ulcer of the stomach there are usually two very definite symptoms. The first, most constant symptom, is *pain*, which is located, as a rule, about half way between the ensiform appendix of the sternum and the umbilicus. This pain is at first intermittent and occurs only after some indiscretion in diet. During this stage pain can be elicited upon pressure, regardless of whether the stomach be disturbed with food or not.

In the second place there is usually some *hemorrhage*. This may be so slight that the blood can be detected only upon careful examination of the stools, or it may be so profuse as to give the stools a characteristic appearance, or it may be so severe as to cause nausea and vomiting, in which case blood will appear in the vomitus. The blood lost may be so considerable that the patient will show marked anemia within a few days; but this symptom usually disappears in a short time if the hemorrhage subsides.

As a rule rather severe gastric hemorrhage does not require immediate operation. In nearly all of these cases the hemorrhage will cease if the patient is kept absolutely quiet and no food or cathartics are given by mouth.

These patients will stand operation much better after they have recovered from their loss of blood. The starvation should be continued for a number of days, for if a small amount of food is given before the patient has fully recovered, the distension of the stomach is likely to reopen the bleeding vessel, and the more often this occurs, the more anemic the patient becomes. With increasing anemia, the coagulability of the blood decreases, and this in itself increases the likelihood of subsequent hemorrhages. In the meantime one ounce of a commercial predigested food dissolved in three ounces of normal salt solution should be given by rectum by the drop method every three hours, also a sufficient amount of warm water should be given in the same manner by rectum to overcome thirst. When feeding by mouth is begun only very small quantities of milk with milk of magnesia should be given every two hours beginning with one ounce of the former and one half drachm of the latter and increasing gradually.

CHRONIC ULCER OF THE STOMACH

Clinical observation seems to show that only a small proportion of acute ulcers of the stomach progress, either continuously or by interruption, until they become chronic. The ulcer, after its first appearance, may go on causing symptoms until the condition may rightly be termed chronic. These symptoms may vary in severity during this period, or they may continue at the same degree of severity, or there may be a complete interruption of the symptoms so that both the patient and the physician may reasonably suppose that the ulcer is permanently healed. The recurrence may be brought about by some

indiscretion in diet, by unfavorable hygienic conditions, or by overwork. A rather common exciting cause is indigestion from overwork, which causes a general neurotic state.

The chief symptoms of chronic ulcer of the stomach are: first, pain; second, obstruction to the passage of food; third, hemorrhage; fourth, malnutrition.

The usual location of pain, as before said, is at a point half way between the ensiform appendix of the sternum and the umbilicus. This pain is increased upon pressure; it is usually increased upon taking certain articles of food. If the ulcer is located in the lesser curvature of the stomach, to the left of its center, the pain is referred to a point a little below the center of the sternum, and pain at this point is felt if pressure is made over the upper portion of the abdomen. If the ulcer is located in the pyloric end of the stomach, but does not involve the pylorus, the pain is usually increased soon after taking food, and the greatest point of tenderness is apt to be in mid-epigastrium. If the ulcer involves the pylorus or extends into the duodenal side, there is usually a very clear-cut, definite train of symptoms, which are the same as those of duodenal ulcer. Early in the history of these cases the appetite remains good, there is no loss of weight and the taking of food brings immediate relief to all symptoms. The burning pain, the eructation of sour gas, return in from one to four hours after eating. Many of these patients suffer from nausea and vomiting, which also returns with the other symptoms. As a rule the heartier the meal the more marked and prolonged the relief. It is very common for these patients to awaken during the night with a severe burning pain in the stomach, which is relieved by taking a glass of milk or other food. Early in the disease these symptoms are periodic and alternate with complete freedom of symptoms. Later on after many attacks the patients have the same characteristic symptoms but they are less definite. The attacks are more severe and continue for a longer time; the appetite may fail or the patient may be afraid to eat on account of the pain, gas and sour eructation; food and drinks give relief, but the time of relief is shortened. Relief may also come from vomiting, irrigation and alkalies, but the pain recurs when the acid contents of the stomach return.

The characteristic point is the time the symptoms appear, and their regularity after meals, and the relief which comes from taking food, or by vomiting or irrigation. Anything that will reduce the acidity below the concentration necessary to irritate the ulcer will stop the pain; hence the benefit of giving alkalinized milk every two hours during the day and an alkaline mixture repeatedly during the night.

Later when complications arise the symptoms may change. Food may not give relief but is apt to increase the pain, which is often nearly continuous. In these chronic cases it is the early part of the history which is most apt to lead us to a correct diagnosis.

Dilatation. Dilatation of the stomach is a late symptom of gastric ulcer. It is caused by the obstruction which the ulcer itself offers in the pyloric channel, or by the cicatricial contraction which results from partial or complete healing of the ulcer.

Hyperacidity. In chronic ulcer of the stomach hyperacidity is usually present, and in duodenal ulcer acids are practically always very high. It has frequently been claimed that the presence or absence of free hydrochloric acid in the stomach, and the presence of lactic acid, can be used in making a differential diagnosis between chronic ulcer and carcinoma of the stomach. This method is not to be relied upon as its employment is apt to lead to serious mistakes. Extensive observations by different investigators have proven that free hydrochloric acid is absent from the stomach contents in a large proportion of normal stomachs in persons over sixty years of age. Again in early

carcinoma the acids are apt to be high and only go down after there is marked stasis of the stomach contents from obstruction during the later stages of the disease.

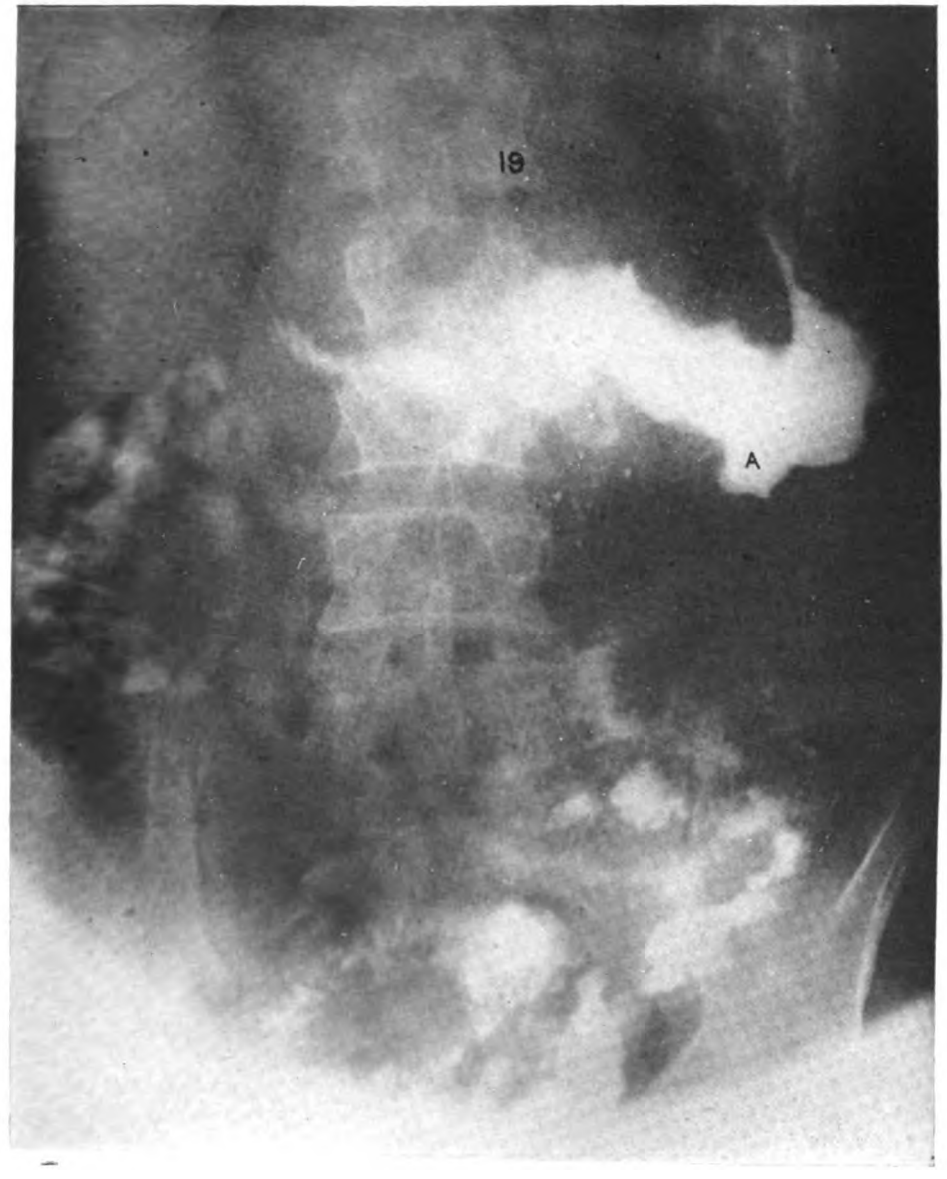
Perforated gastric or duodenal ulcer. A perforation may take place in either the acute or chronic form of gastric and duodenal ulcers. Formerly it was thought that a perforation of a duodenal ulcer was extremely rare. There is no doubt but that in the past many perforated duodenal ulcers occurred and resulted in diffuse septic peritonitis and the appendix was blamed for the peritonitis. This supposition seems reasonable because recently a far greater percentage of perforated duodenal ulcers have been encountered than was formerly supposed to exist. Occasionally in both the duodenal and gastric ulcers the perforation occurs without any previous symptoms, but usually a definite ulcer history can be elicited previous to the symptoms of perforation. Then the patient suffers from a very severe acute attack which usually follows some pronounced physical exertion. Occasionally the attack comes on after some indiscretion in diet, and only rarely does it occur without any apparent exciting cause. The patient suffers from a very acute pain in the upper portion of the abdomen and the pain is usually described as coming on with a feeling as though something had ruptured. There is early nausea and usually vomiting of stomach contents, which may or may not be mixed with blood. The abdominal muscles immediately become tense and there is a condition of shock. Physical examination elicits a rigid condition of all of the abdominal muscles, and especially those of the upper half of the abdomen. There is marked tenderness upon pressure in the epigastrium and usually, but not always, an absence of liver dullness.

The pulse becomes rapid and thready. Early there is no rise of temperature, but this comes on with the progress of the peritoneal infection. If the condition is not diagnosed and relieved early, the symptoms become those of a peritonitis.

Treatment of perforated gastric and duodenal ulcers. Immediate operation is always indicated provided the patient comes under observation during the first twelve hours after the perforation has taken place. Statistics show that the mortality in these cases is about twenty-eight per cent., while in cases which come under observation twenty-four hours or more after perforation has taken place it is more than three times as great. In these latter classes the method of treatment must depend upon the judgment of the surgeon. If the condition present indicates that the leakage has not been great, or the probability of the opening being closed by a plug of omentum or by the presence of other adhesions, it may be wise to place the patient upon exclusive rectal feeding until a circumscribed abscess has been formed, which abscess may then be drained.

In the early cases the operation should be performed immediately and without any preliminary preparation. The incision should be free and in the mid-line. As soon as the abdomen is opened an immediate search for the perforation should be made. This should be carried out in a systematic manner so that the tissues will not be handled any more than necessary.

As soon as the perforation is found it is grasped and held closed temporarily by an assistant, while the surgeon carefully sponges all of the soiled areas to remove as much of the stomach contents as possible, great care being used to cause little or no traumatism to the peritoneum. The remaining portion is now shut off from the field of operation by the placing of some large gauze pads in the abdominal cavity. A stomach tube is now introduced and gastric lavage carried out until the water returns perfectly clear. The perforation should now be closed and in doing this care should be used so that the stomach will be left free from any deformity which may later cause an obstruction.



X-RAY OF STOMACH CANCER.

Radiogram showing general gastric carcinoma. Note very irregular gastric outline due to intrusion of tumor upon gastric lumen; large mass to pyloric side of A.

As a rule the hemorrhage has ceased by the time the operation is performed so it is not necessary to give any attention to this part of the condition.

The opening in the stomach is sutured by placing a row of Connell sutures, covered by a second row of Lembert stitches. The row of sutures should be placed at right-angles to the long axis of the stomach to prevent a narrowing which might later cause an obstruction.

Thorough drainage should be established.

If there has been an extensive extravasation of stomach contents, a second incision should be made just above the symphysis pubis and a drain carried down into the cul-de-sac, while the upper portion of the abdominal cavity should be drained through the upper angle of the original incision.

If the perforation has taken place at or near the pylorus one may expect a certain amount of obstruction to follow and it may become necessary to perform a gastro-enterostomy for relief of same.

It is rarely necessary or wise to perform a gastro-enterostomy at the time of closing an acute perforation of the stomach, because the additional time and manipulation are apt to increase the gravity of the prognosis.

Treatment of chronic gastric ulcer. There are many cases in which a permanent cure is not possible although they have received most careful dietetic, hygienic and medicinal treatment. In any given case the sooner this fact becomes established the better, in order that the operation may be performed before one or the other of the various unfortunate complications may have arisen.

The most serious complications to be considered are (1) perforation, (2) hemorrhage, acute or chronic; (3) emaciation; (4) adhesion to surrounding structures; (5) the implantation of carcinoma.

Besides these serious complications which are apt to occur a number of physiological and anatomical changes develop quite constantly.

Secretion of mucus. In order to protect the ulcer from the irritating gastric juice a large amount of mucus is secreted. At the same time there is a contraction of the muscles in the region of the pylorus to establish a condition of physiological rest. Many of these patients do very well if placed upon an exclusive liquid diet, because with this neither the presence of mucus nor the contraction of the muscles does any harm, especially if the gastric juice is kept alkaline by proper remedies; and, if milk is given, it is medicated so that it will not form coagula.

It is quite different with solid food, as on the one hand this will be rendered much more indigestible by being covered with mucus, while the obstruction caused by the contraction of the muscles in the pyloric end of the stomach interferes with the passage of the food into the small intestine.

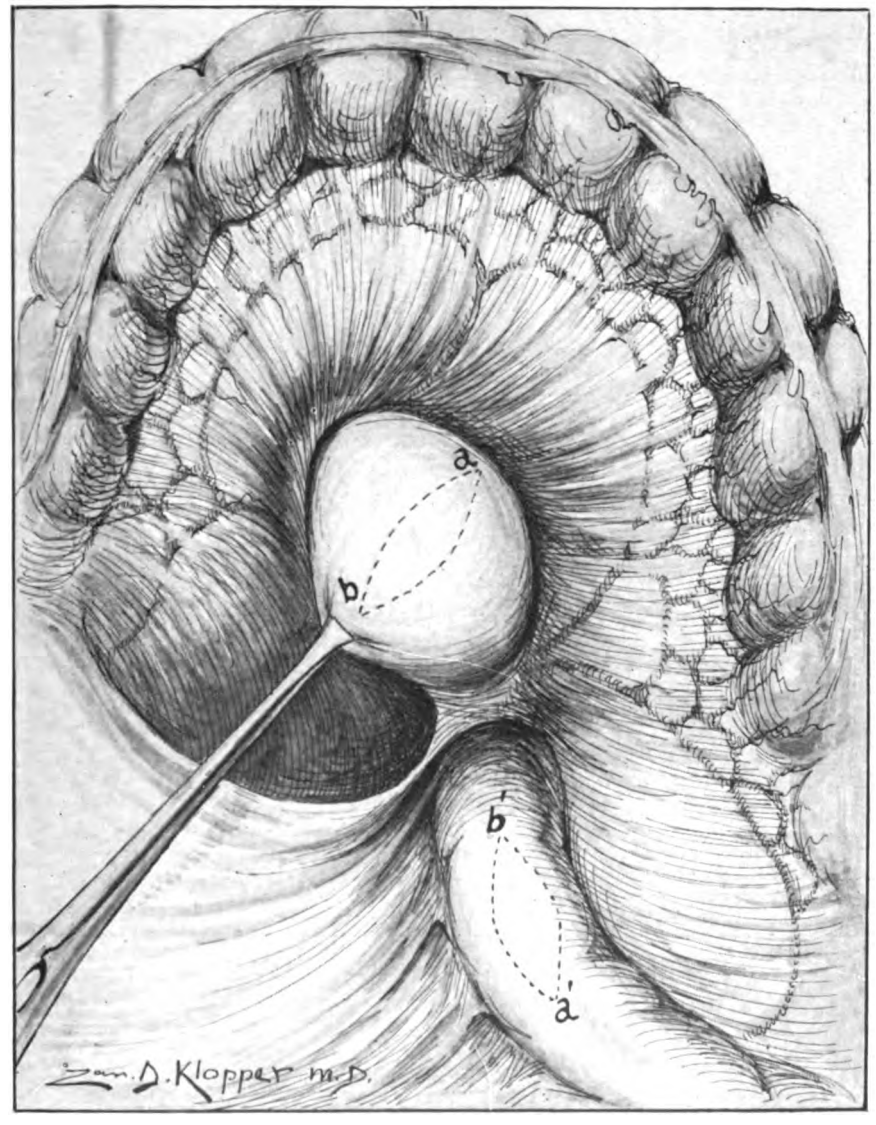
Hypertrophy of gastric muscles. To overcome the former difficulty a great amount of hydrochloric acid is secreted, while to correct the latter there is a compensatory hypertrophy of the muscles of the stomach.

Of course the hyperacidity of the gastric juice increases the irritation of the ulcer, and the muscle hypertrophy increases the traumatism, consequently both of these changes are likely to do much more harm than good.

If the ulcer has healed, in the meantime, all may still be well, but if this has not occurred, conditions are practically certain to go from bad to worse until relieved by surgical intervention. Meanwhile, the following changes may have occurred in the ulcer itself; it may have encroached upon some blood vessel of considerable size causing dangerous hemorrhage; it may have advanced to a point dangerously near to perforation, causing adhesions to other organs, or a perforation into one of these organs, viz.: the pancreas, liver, spleen, omentum or the duodenum, or into the abdominal wall may have taken place. We have personally encountered all of these conditions.

The ulcer may have perforated into the free abdominal cavity, or a carcinoma may have been implanted upon the ulcer.

The most common course, however, results in an obstruction at the pyloric end which may be due to an extensive induration at the base of the ulcer, to a



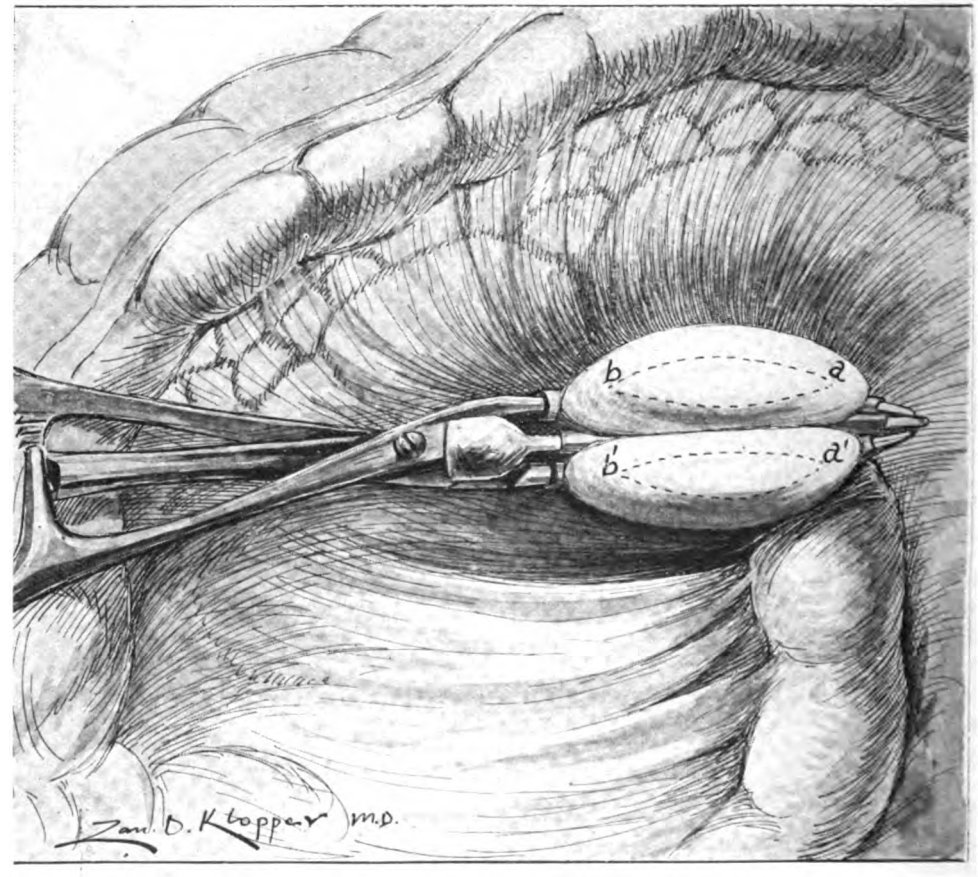
GASTRO-ENTEROSTOMY.

Mayo-Moynihan method of gastro-enterostomy, showing lowest portion of posterior wall of stomach brought through a tear in the mesentery of the transverse colon, and the points on the stomach and jejunum selected for the anastomosis.

cicatricial contraction as a result of the healing of the ulcer, or to a spasmodic contraction of the pyloric sphincter. This obstruction, as has been stated above, will be overcome for a time by the compensatory hypertrophy of the muscles of the stomach but if not relieved this will invariably be followed by an exhaustion of the muscles and a consequent gastric dilatation. This

dilatation may be moderate in degree or it may be excessive. We have seen the lower edge of the stomach resting in the pelvis of the patient.

In the presence of marked dilatation, there always remain portions of food in the stomach and this residual food invariably decomposes so that the patient is forced to absorb products of decomposition instead of products of normal digestion. All fresh food placed in the stomach is at once contam-



GASTRO-ENTEROSTOMY.

Mayo-Moynihan method of gastro-enterostomy, showing forceps holding the stomach and jejunum in position for suture.

inated by the decomposing fluid. This condition accounts for the emaciation or cachexia which is invariably present in advanced cases of this kind. The marked improvement often following the systematic use of gastric lavage is easily explained when one takes into consideration the above conditions.

It is, of course, best not to delay until this extreme development before relieving the patient through surgical means.

Relief in these cases must come by supplying drainage. It has been shown by a very large clinical experience that with efficient drainage of the stomach, by way of a properly executed gastro-enterostomy, better conditions may be established for the patient than by any other present method of treatment.

Such results will vary not only with the skill of the operator but, also, as

regards their permanency, with the care with which these patients avoid hygienic and dietetic abuses after recovering from the operation.

The treatment of duodenal ulcer is the same as that for gastric ulcer.

GASTRO-ENTEROSTOMY

Gastro-enterostomy may be performed for the following conditions: First, for relief of obstruction of the pylorus; second, for the purpose of relieving the irritation due to the passage of food over an ulcer in the pyloric end of the stomach or duodenum; third, for drainage of a greatly distorted stomach; fourth, drainage of a stomach containing an inoperable carcinoma; fifth, for establishing a communication between the remnant of a stomach and the intestine after the pyloric end of the stomach has been removed.

Preparatory treatment. In many of these cases, not sufficiently strong to bear an operation well, because of their impaired nutrition, together with the anemia caused by the loss of blood, it is wise to treat the patient for a time before undertaking the operation. It is well in these cases to remove all decomposing substances from the stomach and intestines by the administration of castor oil, given in the manner described before in the foam of beer or extract of malt, in doses of two ounces. We have used this in many cases and have never seen the slightest harm result from it, but have, on the contrary, constantly observed great benefit. Then it is well to permit the stomach to rest completely for one or two weeks, or even longer, and to administer nourishment by nutrient enemata. Mild saline laxatives may be given by mouth because this will facilitate the healing of the gastric ulcer and will at the same time prevent constipation. Pure olive oil, given at bedtime in doses of two ounces, seems to aid in building up the patient and at the same time leave the ulcerated stomach without giving rise to any irritation.

If there are no acute symptoms it is well to cocainize the pharynx well by spraying it with a four per cent. solution of cocain. The patient should be permitted to swallow a little of this in order to anesthetize the esophagus. After waiting about four minutes, in order to give the cocain an opportunity to take effect, irrigate the stomach thoroughly with normal salt solution.

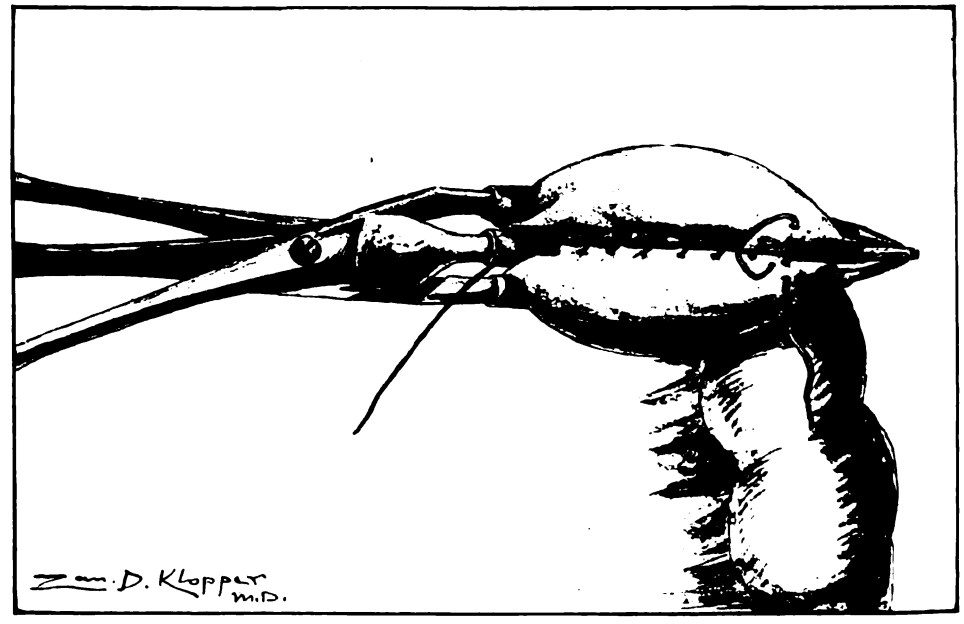
If there are any symptoms of acute inflammatory disturbance in the lining of the stomach it is better to avoid gastric lavage, as this might give rise to hemorrhage from an ulcer.

It is best not to inflate a stomach with gas so long as one suspects the presence of an ulcer, for fear of perforation, but this is necessary in order to determine positively the extent of gastric dilatation. It is safest to insert a stomach tube for the purpose of distending the stomach with gas, and to attach it to an ordinary rubber bulb with which air can be pumped into the stomach slowly and consequently safely. After the degree of dilatation has been determined the gas may be permitted to escape through the tube.

If the patient is in fair physical condition the only preparatory treatment necessary is the administration of two ounces of castor oil the day before the operation and a gastric lavage the evening before, and again on the morning of the operation.

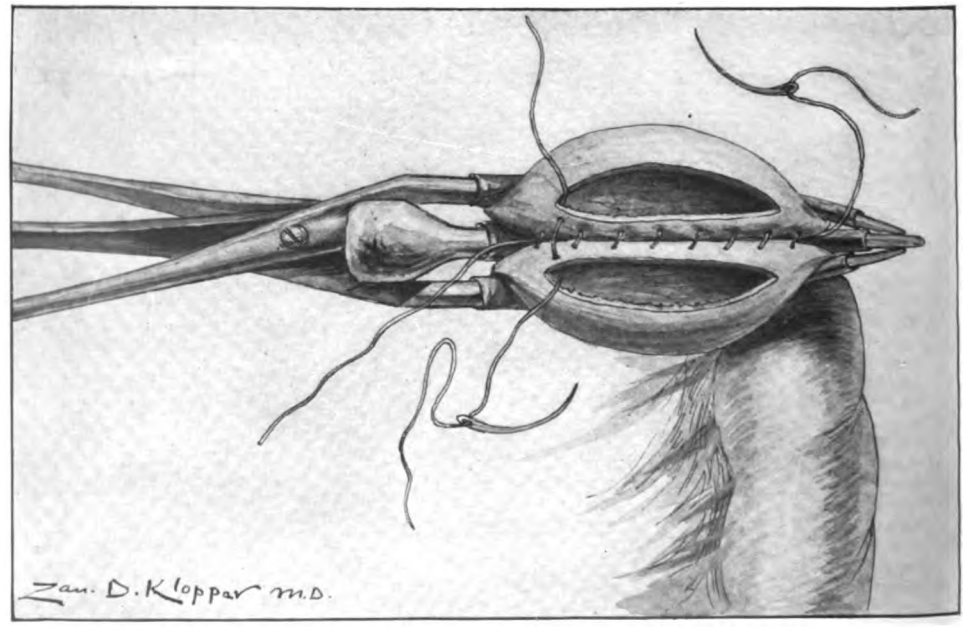
Incision. An incision about four centimeters to the right of the median line will be found most satisfactory in the majority of cases, so that the stomach, duodenum, gall-bladder and appendix can all be carefully inspected. All of these organs should not only be palpated, but should be inspected as well, before it is definitely decided what procedure shall be carried out in any particular case.

During the past few years the authors have used the Moynihan-Mayo method of gastro-enterostomy, which has proved very satisfactory indeed.



GASTRO-ENTEROSTOMY.

Mayo-Moynihan method of gastro-enterostomy showing application of first Lembert stitch.



GASTRO-ENTEROSTOMY.

Mayo-Moynihan method of gastro-enterostomy, showing Lembert stitch in place, the incision made in the stomach and jejunum and the second row of stitches passing through all the coats of the stomach and intestines.

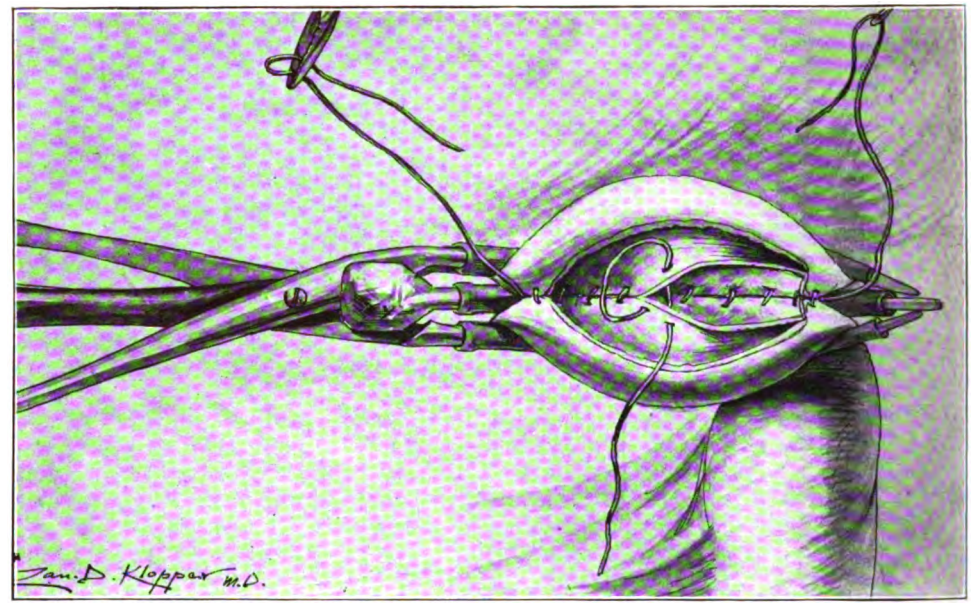
This operation contains the important elements reasonably to be expected in a gastro-enterostomy. It is simple. It places the opening in the lowest part of the stomach. It provides an opening large enough to prevent secondary obstruction from contraction. It establishes an immediate communication between the stomach and the intestine. It leaves the jejunum practically in its normal position and without any angulation. It leaves no loop to cause intestinal obstruction. It prevents the possibility of hemorrhage either during or after the operation. It prevents soiling of the peritoneal cavity by intestinal or stomach contents during the operation.

The first step of the operation is to select a point in the stomach wall for the anastomosis. This point should be made in healthy tissue a considerable distance from the diseased area, if possible. In order to insure the passage of the food permanently through the gastroenterostomy opening we now follow the suggestion of Hartman to make the opening in the stomach near its pyloric end.

It is wise to choose the most dependent portion of the stomach for this purpose, because this will secure a more perfect drainage than could be accomplished in any other way, the walls of the stomach forming a kind of funnel in which all of the sides slope down to the point of anastomosis.

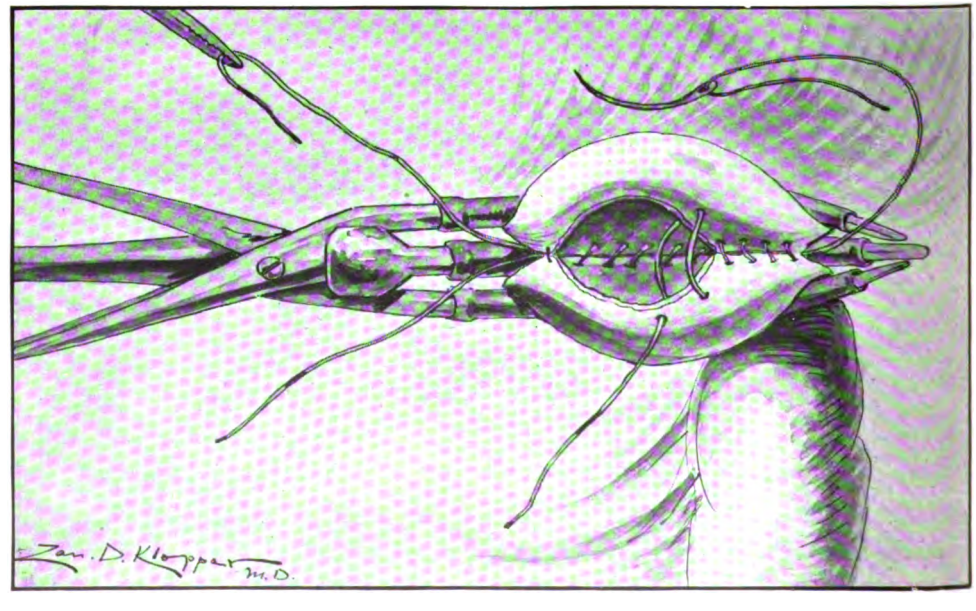
Mayo has pointed out the fact that by doing this, it is possible in almost every case to prevent regurgitant vomiting after gastro-enterostomy.

The transverse colon is brought up out of the wound and its mesentery placed taut, and an opening is torn in the mesocolon at a non-vascular point opposite the crossing of the jejunum. The posterior wall of the stomach is brought out through this opening and the lowest point in the greater curvature of the stomach is grasped by a pair of tenaculum forceps, which would be at the point (a) in the plate. A second pair of forceps should be placed about 8 cm. from the first one in a direction downwards and to the right, as at (b) in the plate. This makes the opening in the stomach in normal direction of the jejunum after it passes through the mesocolon, which is from right downwards to the left in eighty per cent. of cases, according to Lewis. In the other twenty per cent. it is from the left downwards to the right. In these cases the opening should be from left to right in the stomach. As soon as the two forceps, marking the location and direction of the opening in the stomach, have been applied, the stomach wall lying between these two forceps should be grasped by a pair of stomach forceps, the blades of which should be protected by rubber tubing, as shown. Care should be used to have a sufficient amount of the stomach wall project beyond the blades of the forceps to prevent tension during suturing. The jejunum is next picked up, which is found by passing the hand down along the mesocolon to a point just to the left of the spine. The jejunum is now grasped on its convex surface two to five centimeters distant from the point where the intestine passes through the transverse mesocolon at point (b′), and a second 8 cm. distant at point (a′). This portion of the intestinal wall is grasped by another pair of long-bladed forceps in the same manner as the stomach wall, and the two forceps are placed side by side. Gauze pads are now placed about the forceps protecting all of the tissues except the small portion of the stomach and duodenum within the grasp of the forceps. The next step consists in placing a row of Lembert stitches uniting the stomach and jejunum for a distance of about six centimeters. Fine silk or linen thread is usually used in making this stitch. An incision is now made into the stomach about one-fourth of a centimeter distant from the suture line, then a similar one into the jejunum. As these incisions are made any stomach and intestinal contents should be carefully sponged away to avoid soiling any of the tissues. The openings just m



GASTRO-ENTEROSTOMY.

Mayo-Moynihan method of gastro-enterostomy, showing application of second row of stitches posteriorly, which pass through the entire thickness of both stomach and intestinal wall.

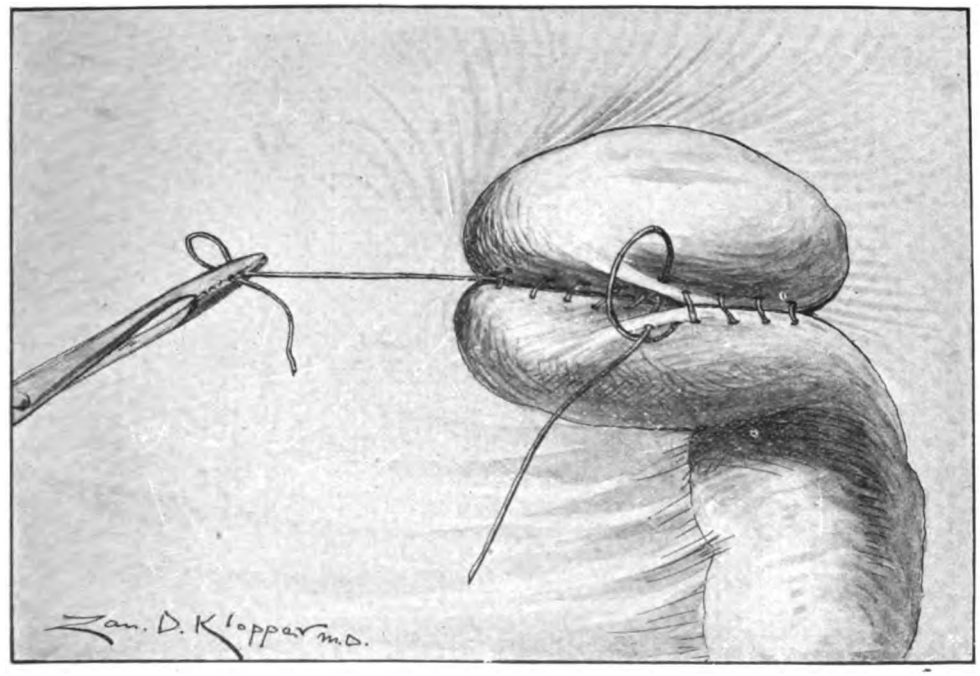


GASTRO-ENTEROSTOMY.

Mayo-Moynihan method of gastro-enterostomy, showing application of the deep row of stitches anteriorly passing through the entire thickness of both the stomach and intestinal wall.

should be about five centimeters in length, which is one centimeter shorter than the first suture line.

A second row of sutures consisting of a running chromicized catgut stitch is placed just in front of the Lembert stitch, which passes through all of the coats of the stomach and intestine. This stitch controls the hemorrhage and approximates the cut edges behind, completing the posterior suturing. The suturing is now continued by means of the Connell stitch which passes through all coats and effectually controls hemorrhage and leakage. The first Lembert stitch is now continued forward approximating the peritoneal surfaces anteriorly. This stitch completes the anastomosis. (See plates.)



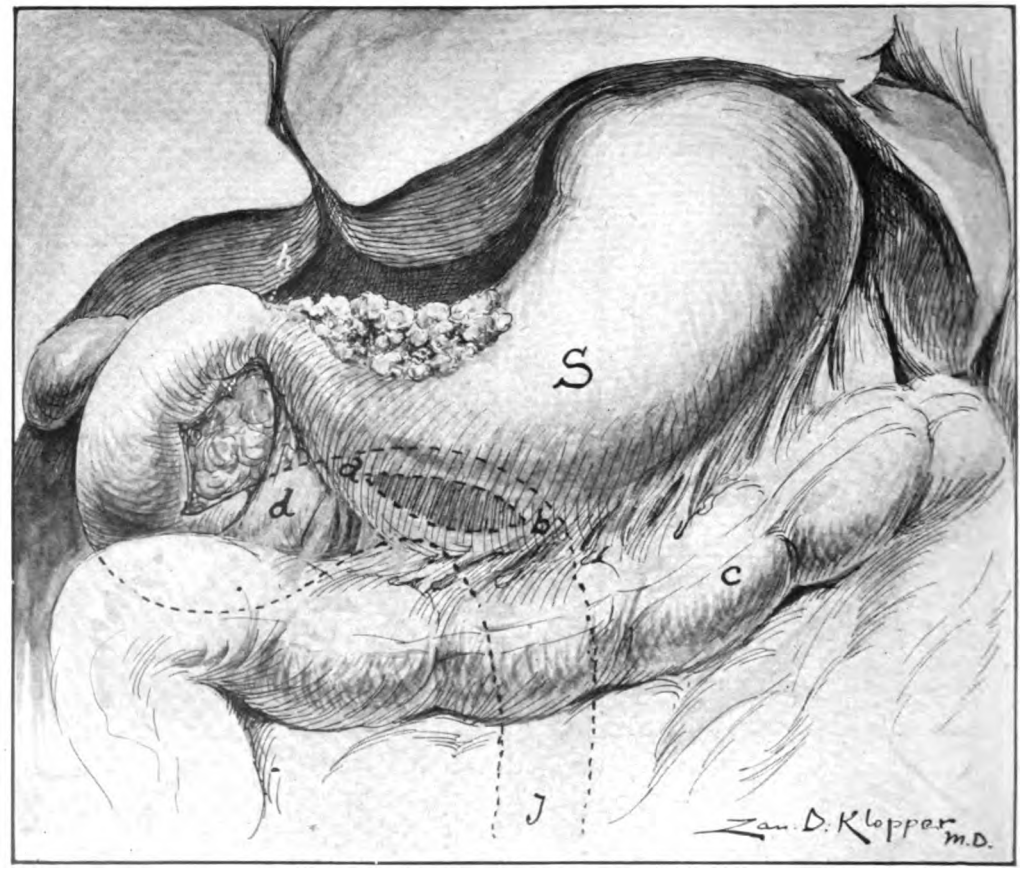
GASTRO-ENTEROSTOMY.

Mayo-Moynihan method of gastro-enterostomy, showing anterior Lembert stitch.

The opening in the transverse mesocolon should now be closed by suturing its edges along the line of anastomosis. This may be attached on the jejunal side, or the stomach, or to both, directly over the line of suture. In doing this care should be used to see that the opening in the mesocolon is large enough so there can be no constriction which might cause an obstruction by kinking the jejunum.

Closing of the pylorus. In patients suffering from gastric or duodenal ulcer who have a very marked obstruction to the passage of food, good results may be expected from a simple gastro-enterostomy, as described above. On the other hand, in cases of ulcer in the region of the pylorus or duodenum in which there is not much obstruction, the operation of gastro-enterostomy is apt to give only temporary relief. In these cases it is well to close the pylorus in some way in addition to making a gastro-enterostomy. The closure is best accomplished by cutting through the stomach at or near the pylorus, then closing both the stomach and duodenal end with a double row of silk sutures.

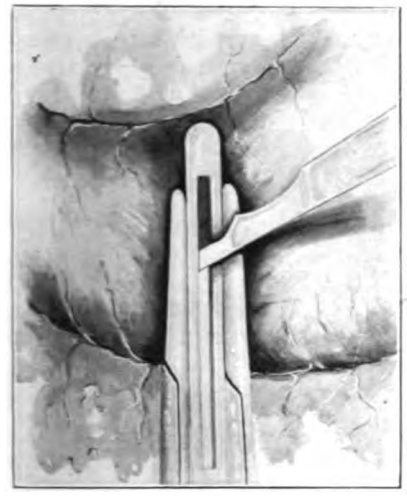
In addition to closing the pylorus, it is often best to make an excision of the pyloric end of the stomach, as advised by Rodman. There have been many methods devised for closing the pylorus without making a section of the stomach or duodenum. The authors have found the following to be satisfactory: A strip of the deep fascia is cut from along the edge of the abdominal incision about one cm. wide and eight cm. long. The pylorus is now closed by folding it from side to side by placing a few silk sutures. A pair of curved hemostatic forceps is passed behind the pylorus. The strip of fascia is grasped in the



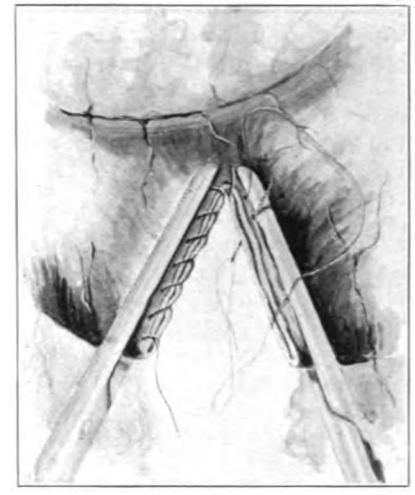
GASTRO-ENTEROSTOMY.

Mayo-Moynihan method of gastro-enterostomy. Operation completed showing relations of stomach, jejunum and transverse colon.

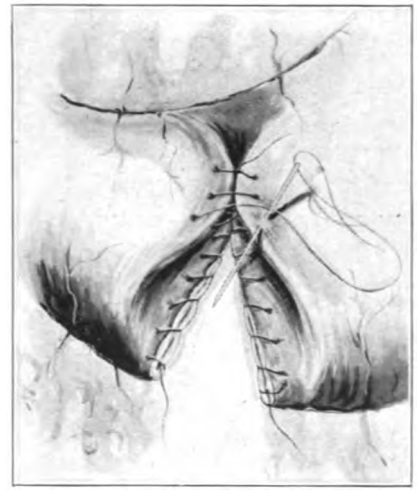
forceps and pulled through behind the pylorus. The forceps are again passed behind the pylorus, grasping the end of the fascia strip a second time, which is drawn around the pylorus again, thus surrounding the pylorus twice with the strip of fascia, the ends of which are now sutured together with silk sutures. This makes a very firm closure, and as far as we have been able to determine clinically the closures have been permanent. Bartlett has recently introduced, as illustrated by the accompanying drawings, a method which has been very satisfactory in his hands and which seems very reasonable and safe and promises to be well worth trying.



A.



B.



C.

EXCLUSION OF PYLORUS. WILLARD BARTLETT'S METHOD.
(*Journal A. M. A.*, Aug. 15, 1914.)

Fig. A represents the application of the special triple clamp, composed of a central clamp provided with a slit to either side of which is attached a crushing clamp in such a manner that the central clamp can be removed without disturbing the lateral crushing clamps. Before removing the central clamp the stomach is cut two-thirds of the distance from the greater to the lesser curvature. The triple clamp is applied to the stomach just proximal to the pylorus.

Fig. B shows the cut end of the stomach above sutured with continuous cat-gut which is to be carried over the other side in the same manner, then both forceps are removed and the entire suture line, as shown in Fig. C by means of continuous Lembert sutures. The sutures in Fig. B grasp all of the layers of the stomach wall, those in Fig. C grasp mucosa, muscularis and submucous connective tissue. The last is the most important of all the layers.

After-treatment of gastro-enterostomy. As soon as the patient recovers from the anesthetic he should be placed on a head rest in a semi-sitting posture. This position favors drainage of mucus into the intestine, which may accumulate in the stomach after the operation, and also favors expulsion of gas through the esophagus. If the patient suffers from nausea or vomiting, gastric lavage should be used. In doing this care should be employed not to distend the stomach. Not more than half a pint of water should be allowed to run into the stomach at one time. If the vomiting recurs, the lavage should be repeated.

Occasionally, the patient suffers from acute dilatation of the stomach. This condition may come on suddenly and is characterized by a sense of fullness and distension of the upper portion of the abdomen. The breathing becomes labored, the heart very rapid and the picture is one of a very alarming state. The condition can easily be relieved by passing a stomach tube. Enormous quantities of gas will escape through the tube and the patient will obtain immediate relief. The pulse and breathing soon become normal and the patient again proceeds in a satisfactory manner.

Feeding. If the patient is not greatly reduced, it is best to feed per rectum for three or four days, and then allow broth, gruel, or buttermilk, or some of the commercial concentrated liquid foods. In anemic patients the authors have frequently allowed liquid food on the second day with good results, and at the same time administered salt solution and some predigested food per rectum. The diet should be carefully regulated for several months after the operation so that the mechanical and chemical functions of the stomach may become as near normal as possible after the changed anatomical relations following the operation. It is well to employ the following diet list whenever there is any irritation following gastroenterostomy. This may be used upon occasions of gastric disturbance for months or years after the operation.

DIET

"Take from two to eight ounces of hot milk at 6-8-10-12-2-4-6-8 and 10. Later you may take the other articles of food on this list at 8-12 and 6.

1st week—Four pints of hot milk daily with medicine; if this is not sufficient to keep up your strength you may add from one to four raw eggs.

2nd week—Same as 1st, and two to four raw or soft-boiled eggs in addition.

3rd week—Same as 2nd, and two to six pieces of very dry toast in addition.

4th week—Same as 3rd, and all kinds of milk or cream soup in addition.

5th week—Same as 4th, and all kinds of mush or boiled rice in addition.

6th week—Same as 5th, and broiled, stewed or boiled beef or mutton in addition, chew and swallow the juice, but not the fibre.

Later add cooked vegetables and cooked fruits, adding only one kind each week.

Later you may swallow the beef or the mutton.

Even after recovering fully, do not eat pastry, pie, pancakes, pickles, pork or puddings. No cake, candy or canned goods. No raw vegetables or raw fruits, unless the latter are perfectly ripe and not sour.

Carefully cleanse your teeth before and after each meal.

Carefully cleanse your tongue and throat by gargling before and after each meal."

EXCISION OF GASTRIC ULCER

Technique. It has at times seemed wise to remove a gastric ulcer radically by excising it entire, and uniting the edges of the wound in the stomach. This is done especially because it has been long known that gastric ulcers are a

predisposing cause to the development of carcinoma. Usually these ulcers do not persist unless there is an obstruction to the passage of the food through the pylorus, and if this condition exists the excision of an ulcer would hardly result in a permanent cure. Moreover, the establishment of free drainage of the stomach by means of a gastro-enterostomy would result in the healing of such an ulcer. However, there is a class of ulcers which stand on the border line of malignant growths, and in this class an excision of the ulcer and surrounding tissues is certainly indicated. This can be done most safely by lifting up the stomach and making an incision around the ulcer, first through the serous and muscular coats, then grasping all of the vessels with hemostatic forceps and ligating them with fine catgut, then lifting the wall of the stomach so as to have the wound extend at right angles with the long axis of the stomach. The mucous membrane may now be sutured without first cutting it, or it may be cut and then sutured with a continuous catgut or silk suture, the first row grasping only the muscular and mucous layers. Over this a continuous Lembert suture is applied. This suture grasps all of the layers down to the mucous membrane, but not through it. By applying this row of sutures transversely to the axis of the stomach one avoids the tendency of narrowing the lumen of the pylorus in case the ulcer is near the pyloric end.

The excision of an ulcer should not prevent the surgeon from making a gastro-enterostomy if this is otherwise indicated, but a portion of the stomach must be selected sufficiently distant from the location of the ulcer to insure satisfactory healing. Of course, the same precautions should be taken in making gastro-enterostomies in these cases as in all others.

In cases in which a chronic ulcer of the stomach co-exists with a stenosis of the pylorus sufficiently small to indicate a gastro-enterostomy, it is doubtful whether an excision of the ulcer is ever indicated, because the gastro-enterostomy will be followed by a perfect drainage of the stomach, and this by the permanent healing of the gastric ulcer.

Rodman has suggested that in ulcer of the pyloric end of the stomach the pyloric end be excised entirely to a sufficient distance beyond the ulcer to include what he calls the ulcer-bearing area, and then to make a gastro-enterostomy similar to that which has been described. Aside from the fact that this method removes the ulcer radically it has the further advantage of removing the portion of the stomach in which carcinoma is most likely to occur secondarily to the existence of an ulcer.

GASTRO-ENTEROSTOMY AND ENTERO-ENTEROSTOMY WITH THE McGRAW ELASTIC LIGATURE

This method has been found very satisfactory in cases in which there is not a complete obstruction of the pylorus. The elastic ligature does not cut its way out for two or three days, so there is no drainage from this source during that time. If the obstruction of the pylorus is complete, there is apt to be an accumulation of fluid in the viscus which cannot pass on until the elastic cord has established a communication between the stomach and the jejunum.

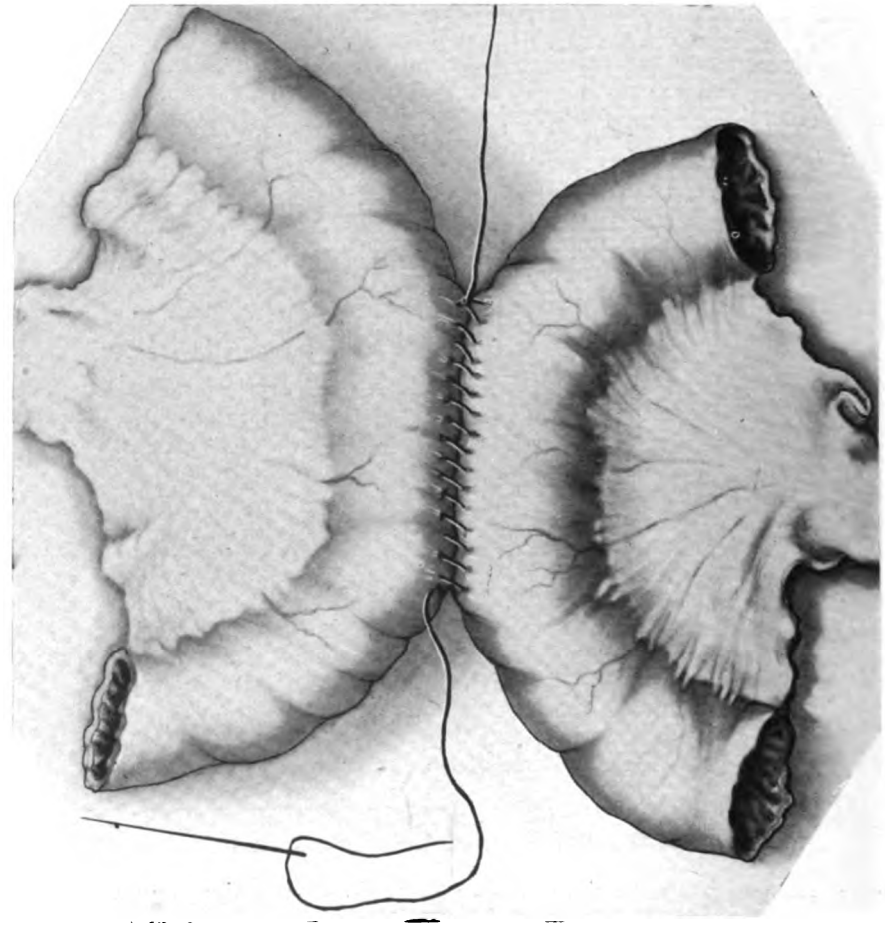
The immediate results have been characterized by an absence of shock and discomfort following the operation and there has been no regurgitant vomiting, vicious circle after gastro-enterostomy, the anterior operation having been employed invariably and the lowest point having been chosen, the anastomosis being made directly above the gastro-epiploic artery.

Technique. In gastro-enterostomy the following steps are taken: The abdomen is opened in the usual manner.

The transverse colon and the omentum are then drawn out through the incision and the jejunum is located a little to the left of the median line, just

where it passes through the mesentery of the colon. By lifting up the colon one can always easily locate this intestine.

It is preferable to make a posterior gastro-enterostomy through a tear in the transverse mesocolon, the beginning of the jejunum being united to the lowest portion of the stomach. The points of anastomosis on the stomach and the jejunum are selected just the same as described in the Mayo-Moynihan



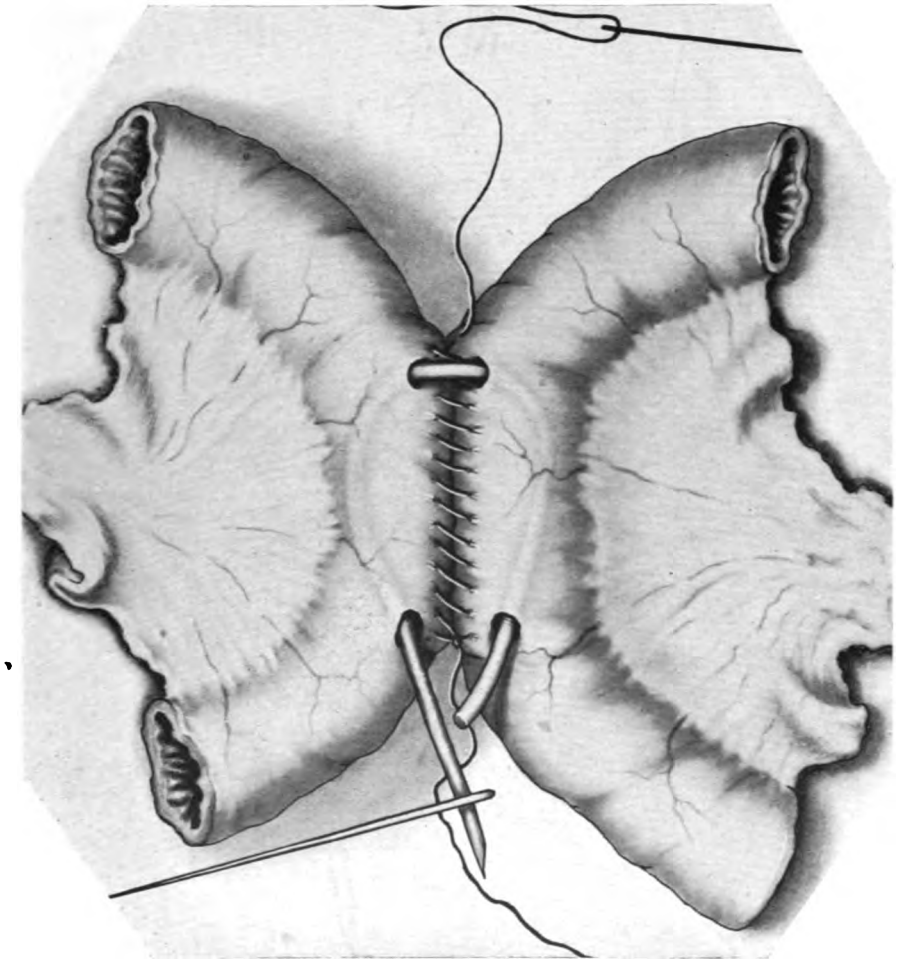
ENTEROSTOMY WITH MCGRAW ELASTIC LIGATURE.

The primary Lembert suture in place.
(From Dr. H. O. Walker's original drawing of Dr. Theodor McGraw's operation.)

operation previously mentioned. The jejunum and stomach are sutured together with a running Lembert stitch for a distance of seven centimeters.

A long needle armed with a McGraw elastic ligature is then passed into the lumen of the intestine, so that its points of entrance and exit are one-half cm. within the line of sutures at each end. The point of the needle is grasped with forceps, then the elastic ligature is stretched in order to decrease its caliber so that it will thoroughly fill the needle holes in the intestine when it is relaxed after being drawn through. The same step is reversed in the stomach.

A strong silk ligature is then placed between the two free ends of the elastic ligature, which are then tied in a half knot. While these ends are drawn very tightly the silk ligature is tied down upon them where they are crossed. It is well to tie a triple knot in the silk ligature to insure against slipping. When the elastic ligature is relaxed it forms a little enlargement beyond the ligature



ENTEROSTOMY WITH MCGRAW ELASTIC LIGATURE.

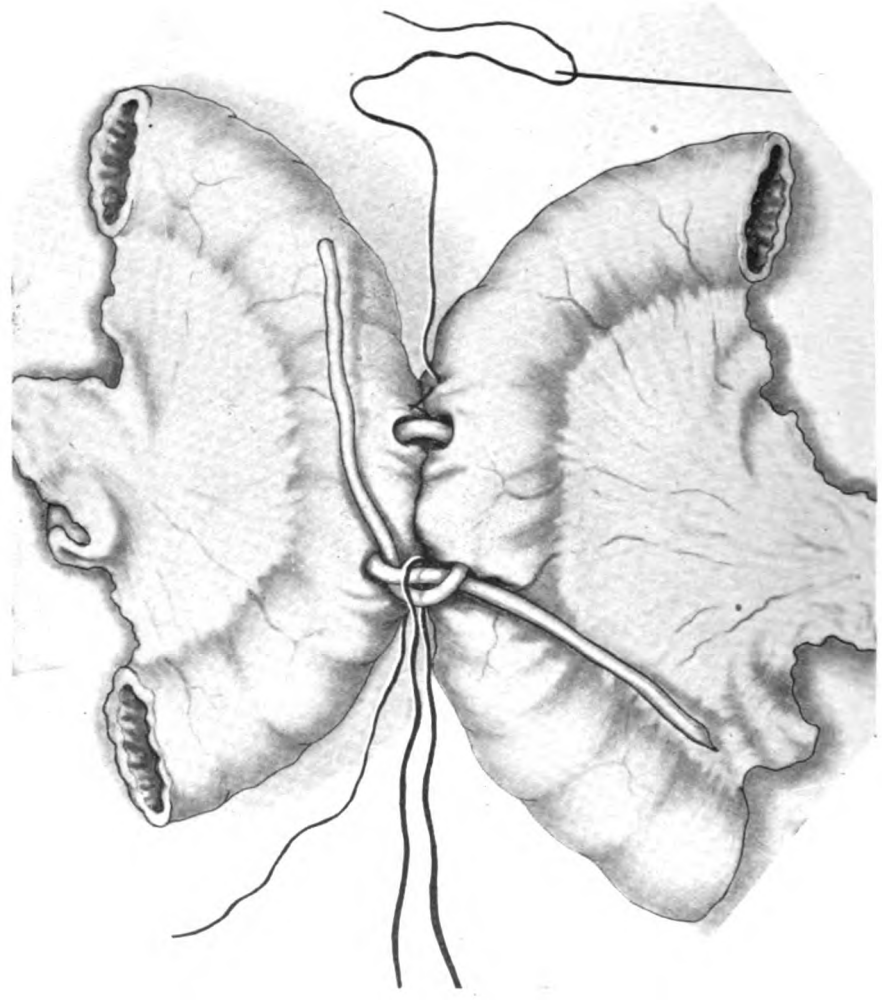
The primary Lembert suture in place. The elastic ligature has been inserted but not tied. (From Dr. H. O. Walker's original drawings of Dr. Theodor McGraw's operation.)

on each side. The ends are cut two mm. beyond the silk ligature. Then the continuous silk suture is completed in front of the elastic ligature so that the latter is completely buried; it is important to apply this suture accurately in order to prevent any leakage when the elastic ligature begins to cut its way through.

The accompanying illustrations are taken directly from Dr. McGraw's original drawings. They represent an enterostomy, but the principle is pre-

cisely the same and it is not difficult to imagine the operation changed to a gastro-enterostomy.

In order to avoid error in performing this operation it may be well to recapitulate the steps:

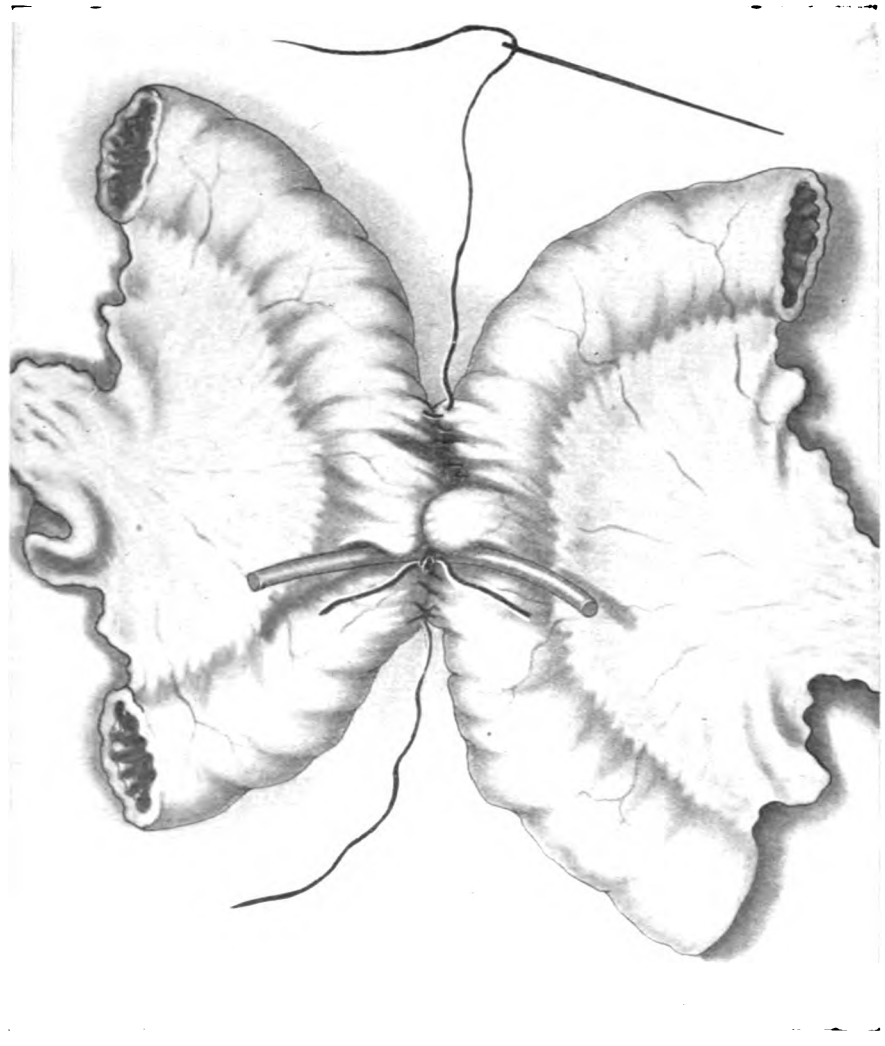


ENTEROSTOMY WITH MCGRAW ELASTIC LIGATURE.

Showing posterior Lembert suture, elastic ligature in place with first loop ready to tie. (From Dr. H. O. Walker's original drawings of Dr. Theodor McGraw's operation.)

1. A round rubber cord 2 mm. in diameter, made of the best material should be used.
2. A posterior row of Lembert sutures is applied.
3. A long, straight needle armed with the rubber ligature is passed into the lumen of the intestine and out again at the desired distance, from 5 to 10 cm. away from the point of introduction.

4. While an assistant holds the intestine the surgeon stretches the rubber in the needle and when quite thin draws it rapidly through the intestine.
5. The same step is repeated through the stomach.
6. A strong silk ligature is placed across and underneath the rubber liga-



ENTEROSTOMY WITH MCGRAW ELASTIC LIGATURE.

The primary Lembert suture in place. The elastic ligature has been tied but the ends have not yet been cut short. The silk ligature securing the tied ends of the elastic ligature has been tied but the ends have not been cut short.

(From Dr. H. O. Walker's original drawings of Dr. Theodor McGraw's operation.)

ture between the latter and the point where the stomach and intestine come together.

7. A single tie is made in the rubber ligature after the latter has been drawn very tightly.

8. The silk ligature is passed around the ends of the rubber ligature where they cross, and tied securely three times.

9. The ends of the latter are released and cut off, being held by the silk ligature.

10. The Lembert suture is continued around in front until the point of its beginning is reached, where it will be tied.

11. Care must be exercised to prevent tying the rubber ligature too far backward and thus getting behind the posterior row of Lembert sutures.

We are thus explicit in describing the steps of this operation because we find that only those who are thoroughly familiar with the method have used it, and apparently all with great satisfaction.

CARCINOMA OF THE STOMACH

Cancer and gastric ulcer. It seems reasonable to suppose that cancer of the stomach is usually implanted upon the base of a gastric ulcer for the following reasons:

1st. In all of the recent or early cancers we have encountered the growth was located in the edge of an ulcer.

2nd. A careful study of the history of late cancer, in which the original ulcer had, of course, been obliterated by the growth, it was possible to elicit a previous ulcer history.

3rd. In studying the development of cancers in other parts of the body we find that a point is usually selected which has been subjected to long continued irritation, as in lip, face, rectal or uterine cancer.

4th. The fact that there are so few cancers of the duodenum, as compared to the stomach, can be explained by the fact that while there is stasis in the stomach there is none in the duodenum. In other words, while food containing the cancer germs will remain in contact with the ulcer of the stomach sufficiently long to obtain a foothold, this is not the case in the duodenum.

5th. It is possible that these germs may require an acid medium to stimulate them to attack the tissues.

6th. It is relatively an easy matter to overlook the history of a previous gastric ulcer, because in the absence of severe hyperacidity the pain in these cases is frequently not sufficient to be remembered through the great distress from which the patient suffers after the cancer has developed.

7th. In our experience a large majority of these patients have habitually eaten large quantities of food which was certain to be infected with manure, such as lettuce, celery, radishes, etc., so the introduction of the cancer germ into the open wound of the ulcer could easily be explained.

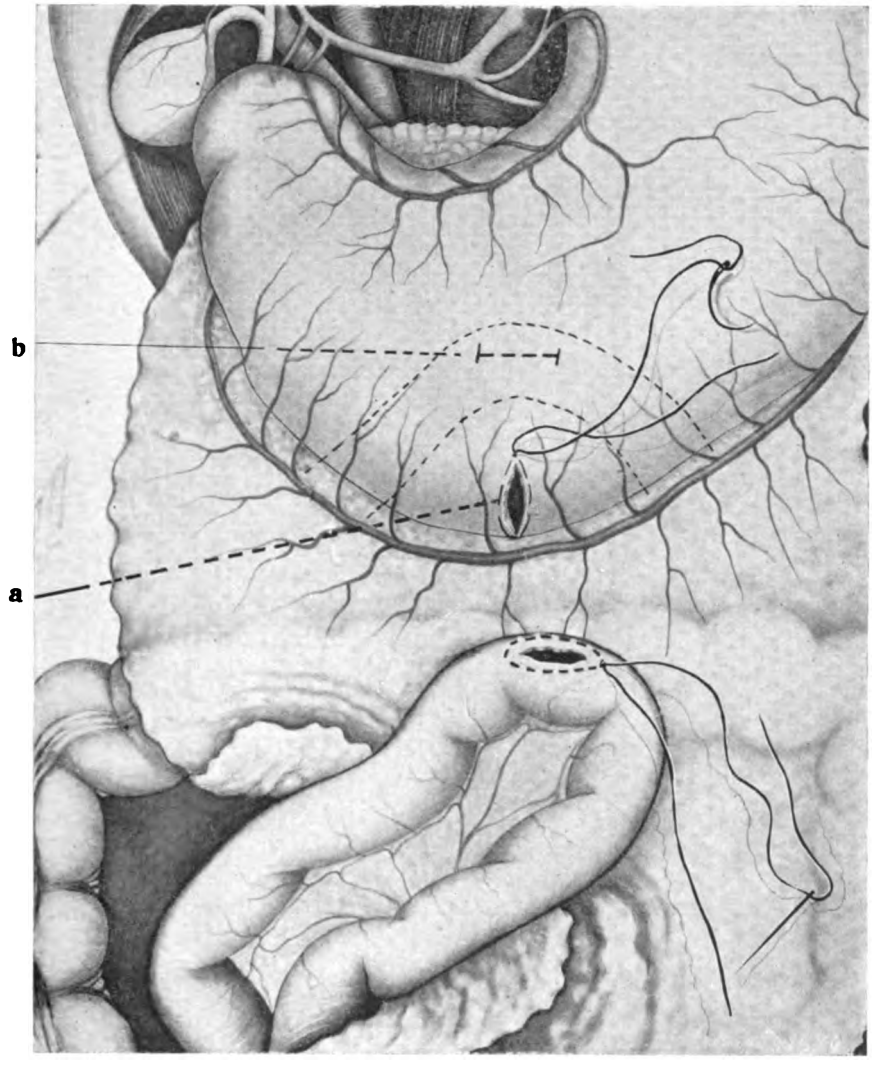
8th. These gastric ulcers are of such long duration that the focus of irritation might readily serve to locate cancer germs which might have entered the circulation through some other portal.

9th. This does not indicate that every case of ulcer of the stomach will ultimately have cancer, any more than that every soldier going to battle will be shot, but it shows the wisdom of closing this opening for the entrance of cancer by curing the ulcer early and permanently.

10th. Much attention should be given to the early history of these cases, and to the prevention of feeding these patients with unclean, uncooked foods.

Importance of early diagnosis. The surgical treatment of cancer of the stomach has received a great deal of attention during the past few years. The technique of resection of the stomach for carcinoma has reached the same degree of perfection as that connected with the surgical treatment of other abdominal conditions, and the percentage of five-year cures, especially in early cases, compares very favorably with the results in surgical treatment of cancer

in other portions of the body, as for instance cancer of the breast and uterus. The important point in the surgical treatment of carcinoma of the stomach is to be able to make an early diagnosis. As soon as the diagnosis is made, or



GASTRO-ENTEROSTOMY.

Represents anterior gastro-enterostomy with the sutures in place, both around the incision in the jejunum and the one at the lowest point in the stomach; (a) represents the proper position for uniting the intestine to the stomach; (b) represents the usual position, which is wrong, giving rise to vomiting, because it forms a pouch into which the contents of the jejunum may empty.

Taken from Dr. W. J. Mayo's original drawing.

it is even strongly suspected to be a case of carcinoma of the stomach, the person becomes a surgical patient and should be subjected to at least an exploratory incision.

Typical case. The patient is a married woman, thirty-five years of age, giving the following history. Her family history is negative. She suffered from measles as a child, menstruated at seventeen, regularly, but painful, before the time of her marriage at the age of twenty-eight. One year later she had a miscarriage, but has otherwise been in good health. Five months ago, patient began to suffer from acid stomach and from the presence of a feeling of fullness after eating, accompanied by eructations of gas. She has also suffered severely from constipation. For the past two months she has vomited, usually after taking solid food, occasionally, however, she would retain any kind of food in her stomach for two or three days and then vomit all that she had taken during this period of time. She has not suffered any pain and her temperature has been normal. She has occasionally been slightly jaundiced. The patient has never been very well nourished.

Present condition. The patient is quite emaciated, being fifteen pounds below her usual weight; her tongue is coated and she is very hungry; her bowels are constipated. Cathartics give rise to nausea. Temperature is 98° F., the pulse 86, regular and fairly strong. Heart, lungs and kidneys are normal. The abdomen is distended, but not tender upon pressure. There is no free fluid in the peritoneal cavity. The stomach is prolapsed and distended, the lower border extends two inches below the umbilicus. Succussion sounds are marked upon shaking the abdomen. A hard, elliptical body, movable with respiration, can be felt in the right hypochondriac region. There is a tympanitic space between this mass and the costal arch. The mass is movable in every direction.

Diagnosis. This history would indicate beyond a doubt that there exists in this case an obstruction of the pyloric end of the stomach. This may be due to the presence of a malignant growth corresponding to the tumor, which can easily be demonstrated, or it may be due to a non-malignant stricture of the pylorus, or to a short bend in this part of the alimentary canal. The tumor is farther to the right than we usually find a carcinoma of the pylorus and it might readily be a distended gall-bladder or even a tumor of this organ, or it might be a movable kidney containing a small tumor. The youth of the patient might be considered an argument against the diagnosis of carcinoma of the pylorus.

Notwithstanding these facts, there can scarcely be a doubt but that this patient is suffering from the presence of a carcinoma obstructing the pylorus, because the history and the findings upon physical examination—hyperacidity, pain, hemorrhage, dilatation, emaciation, and tumor—are very characteristic.

Indications for operation. Judging from the size of the tumor and the amount of obstruction present, it is not at all likely that an operation will result in the removal of the malignant growth, or in case a removal is accomplished it is not at all probable that this will result in a radical cure. Consequently the best that can be expected from an operation is simply a certain degree of temporary relief. This relief will consist in the establishment of a free communication between the stomach and the small intestine. As a result of this the nausea, vomiting and pain will rapidly disappear, the nutrition will improve and the patient will no longer absorb decomposition products from the stomach. Her cachexia will consequently disappear, she will gain in weight and strength and will imagine herself quite well for a time.

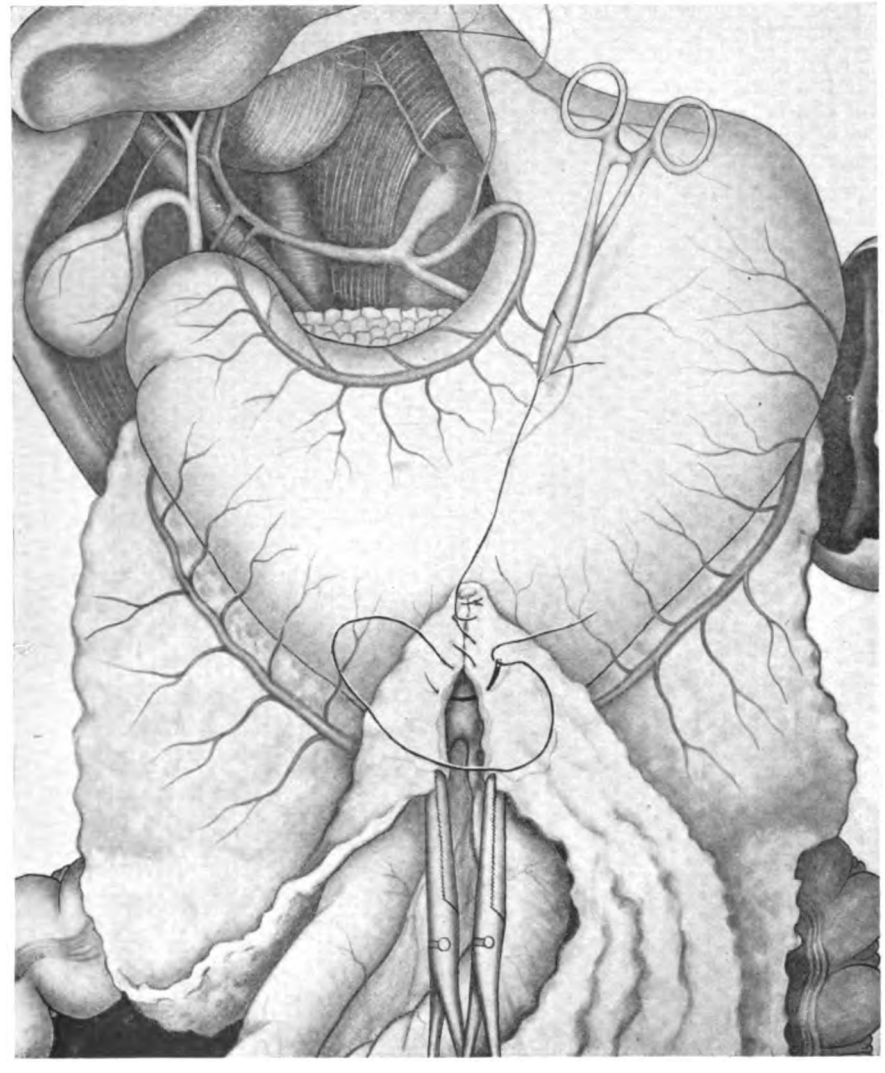
Sooner or later the carcinoma will have involved so great a portion of the stomach and the surrounding organs that she will succumb to the disease, but it may be a considerable time before this is to be expected.

Preparatory treatment. Gastric lavage will be performed night and morning for one or two days until the stomach contents no longer have an offensive odor. The morning of the day before the operation two ounces of castor oil will be introduced through the stomach tube, after the gastric lavage has been completed. In the meantime some aseptic predigested food will be given every three hours.

Should the oil not produce a very free evacuation of the bowels, the same dose will be given in the same manner every twelve hours until the desired effect has been accomplished. If the oil is not retained in the stomach free evacuation of the bowels will be accomplished if possible by means of enemata.

On the morning before the operation the stomach will again be thoroughly cleansed by means of gastric lavage.

Technique. The incision is made as in the previous case. We find as we had expected, an extensive involvement of the entire pylorus with the tumor



GASTRO-ENTEROSTOMY.

Represents anterior gastro-enterostomy with the omentum folded over the point of union between the stomach and the jejunum to increase the safety of the operation.
Taken from Dr. W. J. Mayo's original drawing.

extending well up on the lesser curvature. The lymph glands to a considerable distance, especially behind the pylorus and along the lesser and greater curvature of the stomach, are involved. It seems plain that the complete removal of these glands, together with the tumor, is not possible, and a partial removal would only serve to excite a more rapid growth, consequently no benefit could

come from an attempt at a radical operation and it would not be wise to make the effort.

The healthy portion of the stomach is greatly dilated on account of the almost complete closure of the pyloric opening. The greater curvature extends more than two inches below the umbilicus. The operation from which the greatest amount of benefit will be derived is a simple gastro-enterostomy.

In planning a gastro-enterostomy for drainage in carcinoma of the stomach, the opening should be chosen at a point quite distant from the carcinoma. In the majority of cases an anterior gastro-enterostomy answers this purpose better than a posterior. In the past the authors frequently used the Murphy button for making the anastomosis.

The jejunum is now brought up out of the abdominal wound and a point selected twelve to sixteen inches from the mesentery of the transverse colon. A small, longitudinal incision is made through the peritoneum and muscular coat down to the mucous coat, then a purse-string stitch is applied. Then the mucous membrane is cut and the larger segment of a Murphy button is inserted and the purse-string suture carefully tied. It is important to apply the purse-string suture close to the edge of the wound in the intestine in order to prevent the tissues being drawn together in irregular masses around the button.

By drawing a small bunch of moist cotton through the hole in the button sufficiently firm to prevent leakage much annoyance may be avoided, because this pledget of cotton can be easily removed before uniting the two lobes of the button. This intestine with the button in place is now surrounded with a piece of moist gauze and placed to one side while the other half of the button is inserted into the stomach in very much the same way.

We have selected the most dependent portion of the greater curvature of the stomach, but here we find the large artery, the gastro-epiploic, with its large branches extending at right angles with the greater curvature of the stomach. We will select a point half way between two of these branches and make our incision through the peritoneal and muscular coats down to the mucous coat. The muscular coat will retract somewhat, and here again we exercise the same care in inserting the purse-string suture near the edge of the wound, in order not to draw too much tissue between the rims of the button. The smaller segment of the button is now inserted and the purse-string suture tied. It has been so applied as to avoid having the knots in the two sutures meet when the button has been closed. After withdrawing the pledget of cotton from the opening, the two segments of the button are adjusted to each other and pressed together with a moderate amount of force, care being taken to push in any small portion of serous surface which might not have adjusted itself spontaneously.

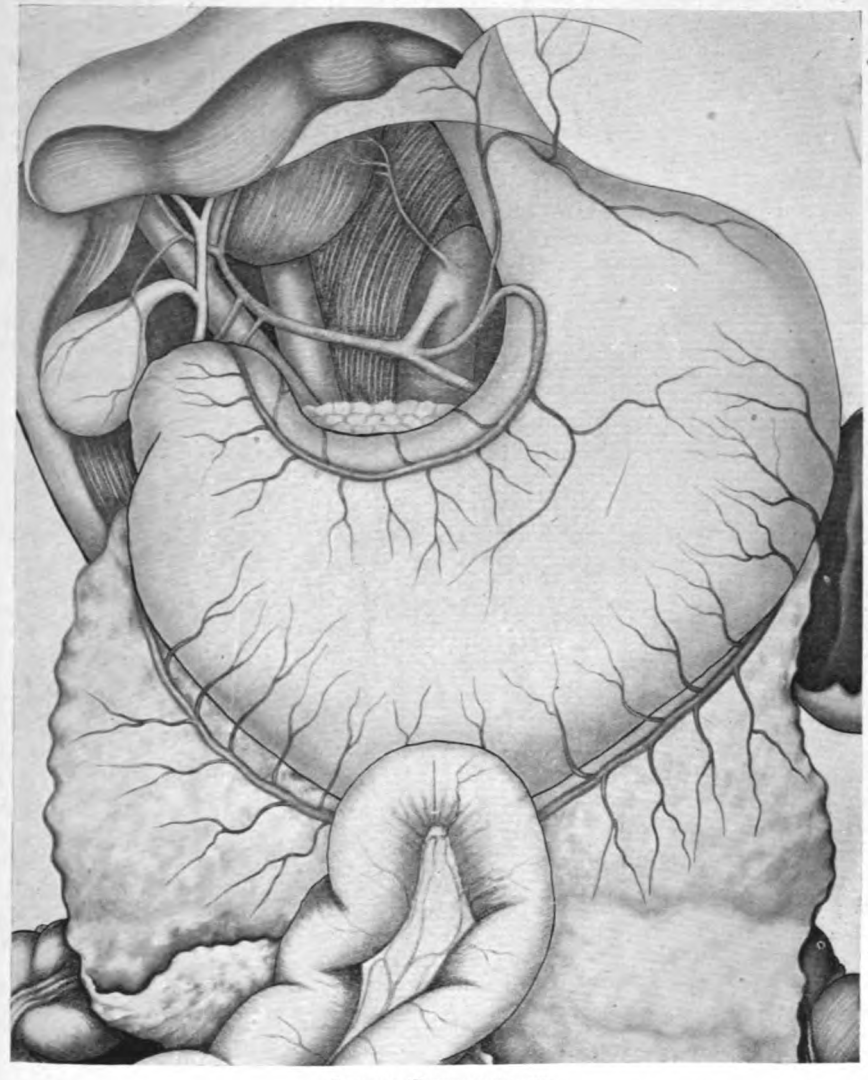
A stomach tube should now be inserted and the stomach should be carefully irrigated with water at a temperature of 105° F., to wash away any mucus or blood which may have been collected, and to demonstrate the fact that the union between the stomach and jejunum is perfect.

In doing the anterior gastro-enterostomy it is wise to add Hartmann's suggestion of stitching the intestine to the stomach wall an inch above the proximal side with a mattress suture. A second suture is placed in same manner about one inch on the distal side of the anastomosis. This prevents the jejunum from kinking on the gastro-jejunal opening.

It is again important to select the lowest point in the stomach, in order to secure perfect drainage of this organ, and especially for the purpose of preventing the flow of bile from the duodenum into the stomach. It is also important to remain as great a distance from the diseased portion of the organ

as is compatible with securing the most dependent portion; fortunately, the latter usually lies very well to the left.

In patients who are greatly reduced in strength it is well to reinforce the



GASTRO-ENTEROSTOMY.

Anterior gastro-enterostomy. The jejunum being united to the stomach at its lowest point, which will prevent the regurgitation of bile, "vicious circle."
Taken from Dr. W. J. Mayo's original drawing.

Murphy button to a certain extent by the use of a cuff formed out of the omentum, as shown in the plate.

It has occasionally happened after a gastro-enterostomy in greatly reduced patients, that a sudden motion, such as would be experienced during a severe paroxysm of coughing, sneezing or vomiting, would be followed by a loosening of the anterior portion of the union between the stomach and the intestine.

In these cases it is wise to enforce this union by employing the omentum, which is always well nourished and abundantly supplied with blood vessels, and will consequently make up for the deficiencies in the nutrition of the stomach wall.

Non-operative cases. In case an operation is refused by a patient in this condition, we try to secure a degree of comfort by the use of opium. We also teach him to perform gastric lavage whenever he is nauseated. In many of these patients one can secure a great degree of comfort by pursuing the following plan: Gastric lavage is performed in the morning directly before taking breakfast, which should consist as much as possible of food that can be absorbed from the stomach, therefore liquid, in order not to clog whatever slight opening may still exist in the pylorus. Two hours later the remnants of this food are again removed by gastric lavage. The same plan is followed at noon and at night. In this manner the food is not mixed with decomposing mucus and remains from a previous meal, which are partly decomposed and partly digested.

After a short period of practice these patients frequently enjoy this plan, and many of them improve greatly in appearance, because they no longer have to absorb these products of decomposition. It is not infrequent for patients to gain in weight under this form of treatment, and there is usually a great reduction in pain in cases in which this symptom is marked.

A fear of producing hemorrhage by the use of gastric lavage has been expressed, but we believe that this danger is greatly over-estimated. Before we became familiar with the use of the Murphy button, we had occasion to treat many cases in the manner just described, and never found any difficulty from hemorrhage.

RESECTION OF THE PYLORUS

Had we encountered a removable tumor of the pylorus in the case above outlined, our treatment would not have varied as regards the communication between the stomach and the intestine, but this would have been preceded by the excision of the pylorus by a method which will be described presently.

There are several valid reasons for preferring a gastro-enterostomy, such as has been described, to a direct end-to-end union between the stomach and the duodenum after the excision of the pylorus: 1. It is much more easily accomplished; 2. The operation requires much less time, which is an important feature in many of these cases; 3. Surfaces completely covered with peritoneum can be united; 4. There is no tension; 5. The adjustment can be made more accurately, because in the end-to-end approximation of the duodenum to the stomach there is a great difference in the lumen which varies with the amount of tissue that has to be removed from the stomach; 6. The attachment being at the most dependent portion of the stomach, the drainage is more likely to be satisfactory.

With the hearty consent of W. J. Mayo the following extract is used. His work in this field is classical and authoritative. The accompanying illustrations are also taken from his original drawings.

Radical operations for the cure of cancer of the pyloric end of the stomach. [Seventy per cent. of all gastric carcinomata involve the pyloric portion, and sixty per cent. have their origin at the pylorus or within three inches of it. Considering the fact that radical operation was successfully performed in the time of Billroth (1881), before the inception of modern abdominal surgery, and that during the succeeding years more or less work has been done in this field, it is curious that pylorectomy and partial gastrectomy have not as yet achieved an accepted surgical position. There have been a number of reasons for this anomaly; first, a belief that the diagnosis could not be

made before the case had advanced beyond the possibility of cure, and, second, that the operation was difficult, prolonged and bloody, with an almost prohibitive mortality. The first proposition is to a considerable extent true; but not entirely so, as we have in exploratory incision the one diagnostic resource which is reliable and which must be resorted to in the large majority of cases before a surgical diagnosis can be made. Without it the truth is but slowly established together with progressive hopeless involvement. Exploration can be safely accomplished through a small incision and with a short time of disability. It is said that the patient will not submit to an abdominal incision upon suspicion. Herein we do the intelligence of the public an injustice; we have seldom been refused the opportunity, when the matter has been fairly and candidly laid before the patient and his friends. The plea for delay has more often come from the attending physician.

Without going into the question as to the symptoms which would constitute a basis for exploration, the writer would express the opinion that the early diagnosis must be based upon clinical phenomena, the result of observation and experience.

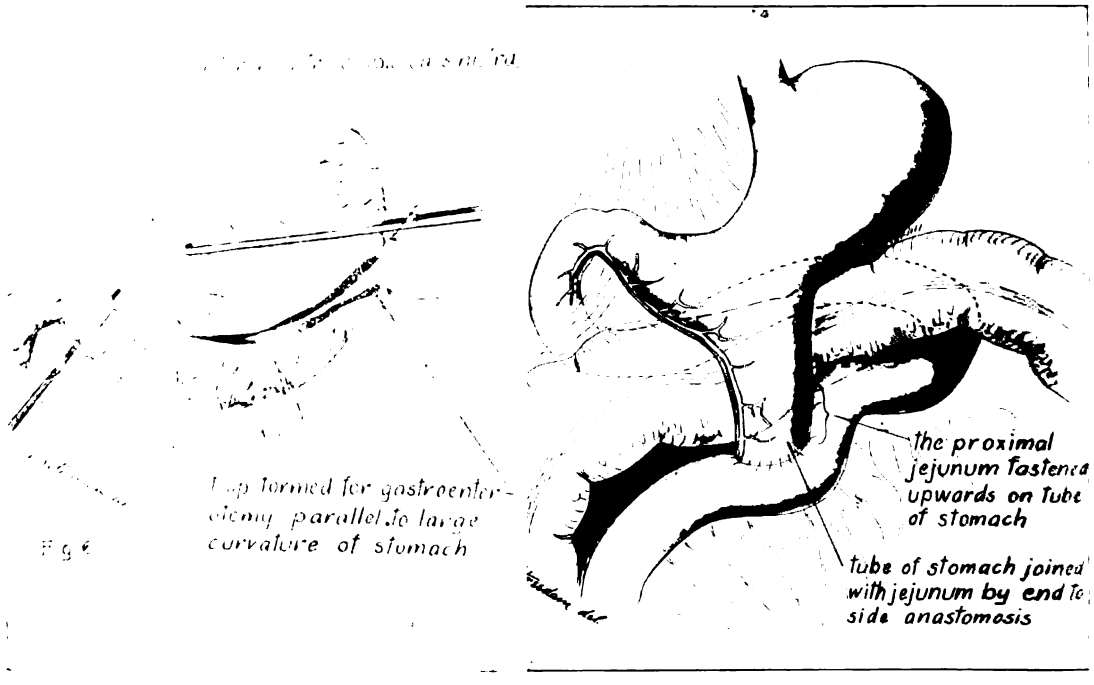
Some misleading statements. In attempting to solve some of these problems we have encountered a number of misleading statements, which seem to have been generally accepted. Of these, three are of sufficient importance to deserve brief discussion: (a) *The value of laboratory methods of diagnosis;* (b) *the significance of a palpable tumor;* (c) *the history of previous ulcer.*

(a) *Laboratory methods of diagnosis* are chiefly based upon the chemistry of the gastric secretions (test meals and so forth) and the microscopical examination and chemical reactions of gastric "findings," as well as the urine, feces and blood. In the surgical stage these examinations have little value, but gain in diagnostic importance with the progress of the disease, to become of the greatest value only when the patient is in a hopeless condition. My colleagues, Drs. Graham and Millet, in the examination of somewhat over 1,500 stomach and duodenal cases, of which 430 came to operative demonstration, showed this beyond question. These examinations should be made, but exploration should not be delayed by reason of the inconclusive nature of the results.

(b) *Tumor.*—The dictum was advanced many years ago that the presence of a tumor of itself demonstrated inoperability. This is by no means true; a small movable tumor in the pyloric region may be a favorable indication. The early diagnosis of cancer depends in a great measure upon the introduction of mechanical phenomena from obstruction at the pylorus, late vomiting, dilatation, pain, gas, etc., with or without palpable tumor, and it is the interference with gastric motility—the progress of food from the stomach—which early calls the attention of the patient to his trouble, and not the presence of the cancer itself. Without these symptoms a surgical diagnosis would seldom be made. In our experience the patient with marked symptoms of cancer of the stomach, but without any evidence of pyloric obstruction, proves on exploration to be the victim of advanced and hopeless disease of the body, in which there were no symptoms during the operable period.

(c) *A history of previous ulcer* with complete recovery during a prolonged period of time is apt to be taken as an indication that a present gastric trouble is due to a recurrence of the ulcer and lead the patient and attendant physician to postpone interference. Usually this is true, but too often the renewal of symptoms is due to cancer development upon an ulcer base. We have had this occur a number of times. The author has become a convert to the belief that cancer frequently develops upon an old ulcer scar. Graham, in 145 cases of cancer of the stomach which came to operation at our hands, found a previous history of ulcer in sixty per cent. of the cases, although years may have

elapsed after healing of the ulcer before the cancer began. Lehert says that nine per cent. of ulcers develop cancer—that is, pass directly from the one condition to the other. Ochsner, Fütterer, Dunn and others believe that the irritation of healed ulcer defects in the mucosa furnish the starting point for the majority of cancers. Murphy rightly says that precancerous lesions can usually be demonstrated in the history of the case. It is to be noted that the topography of cancer and ulcer is nearly identical.


Flap formed for gastroenterostomy parallel to large curvature of stomach
the proximal jejunum fastened upwards on tube of stomach
tube of stomach joined with jejunum by end to side anastomosis

BECK'S GASTRO-ENTEROSTOMY.

A communicating tube has been constructed, taking a flap from the cardiac end of the greater curvature of the stomach and uniting the defect produced by this, constructing the tube and implanting it laterally into the jejunum either behind or in front of the transverse colon.

The above figures show the manner in which the flap is constructed. The cavity of the dome of the stomach and the duodenum are closed with two long jawed clamps which also compress the blood-vessels and prevent hemorrhage.

The determination of operative intervention. The second proposition concerns the operation itself. There are two local manifestations of the malignant process upon which the advisability of operation depends: (a) *Local extent of disease;* (b) *lymphatic involvement.*

(a) *Movability of the growth* is a very important factor in judging of the extent of disease. Limitation to the pyloric end of the stomach is also of prime importance. Extension to neighboring organs usually contraindicates operation, with the occasional exception of the transverse mesocolon. The duodenum is rarely involved to any considerable extent. Adhesions are a serious complication, not only because they are the advance guard of the cancerous process, but in that they add to the difficulties and dangers of the operation. Haberkant found a death rate of seventy-three per cent. operated

upon in the face of extensive adhesions, and twenty-seven per cent. without such complication. Mikulicz had a mortality of seventy per cent. when there was close adhesion to the pancreas. A moderate amount of adhesions which permit of free motility of the growth have not materially influenced the prognosis in our experience.

(b) *Lymphatic infection.* This is the most important element in the attempt at cure of cancer of the stomach, because the most difficult to estimate in its extent. The mere presence of enlarged lymph nodes does not necessarily imply cancer. Glandular hyperplasia occurs with great frequency in ulcer as the result of infection, and the location of such lymph nodes may lead to the site of ulceration, as pointed out by Lund. Ulcerating gastric carcinomata may give rise to infected glands without epithelial invasion, but in practically all cases of gastric cancer the lymphatic structures are involved. In the Breslau clinic twenty cases out of twenty-one showed glandular involvement. In a general way the lymph channels follow the blood vessels. On the lesser curvature the blood and lymph vessels lie in the wall of the stomach itself, and, as pointed out by Mikulicz, it is necessary in every case of pyloric cancer to remove all of the lesser curvature to the gastric artery. For convenience this situation on the lesser curvature for beginning of the line of excision may be called the Mikulicz point of election.

To Cuneo we owe a debt of gratitude for his masterly exposition of the lymph drainage of the stomach. He showed that there are but few lymph glands along the greater curvature, and these are confined to the pyloric region. (See plate.) These glands, with the blood vessels, lie at some distance from the greater curvature, thus enabling rapid expansion and contraction of the stomach without interference with the circulation. The lymph stream in this situation flows from left to right and does not drain more than one-third of the adjacent stomach, two-thirds going into the lymph channels of the lesser curvature. In the immediate vicinity of the pylorus, however, it drains its fair share.

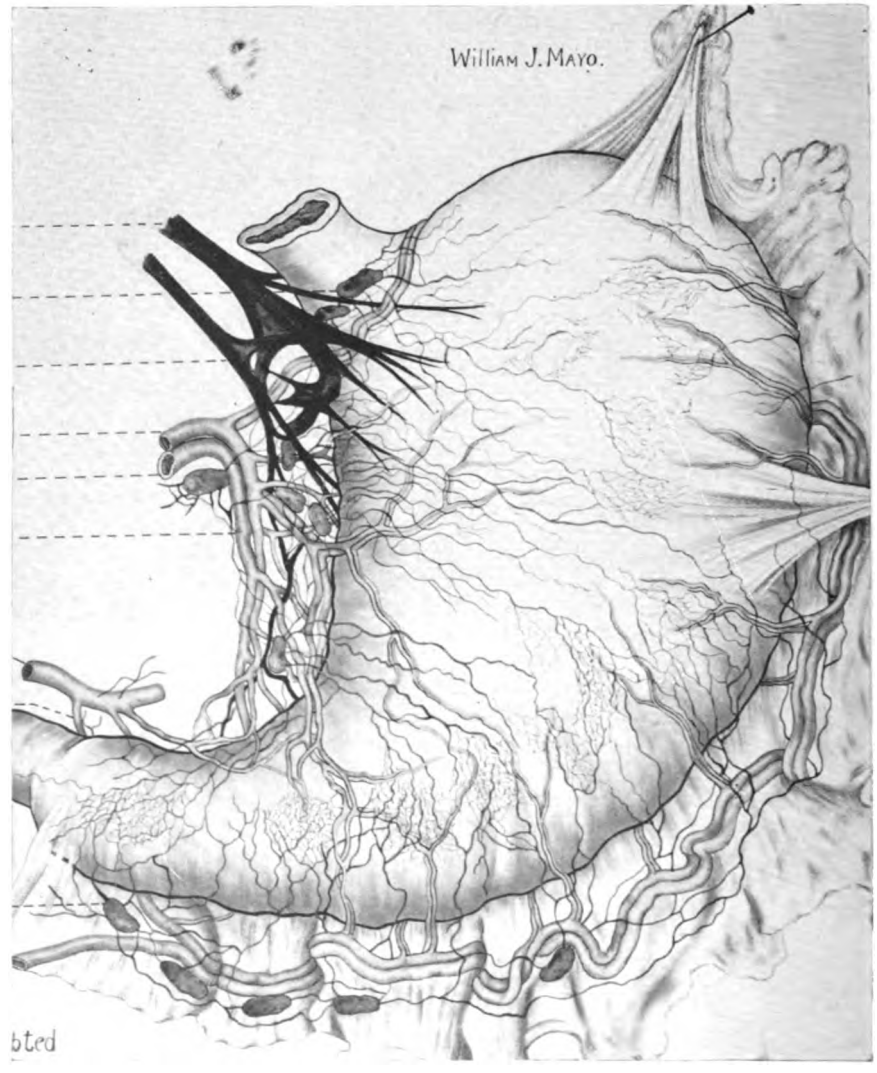
The lymphatics of the greater and lesser curvatures enter the deep receiving glands about the cœliac axis on the anterior surface of the aorta. Cuneo practically demonstrated that the fundus and two-thirds of the greater curvature are free from lymphatic involvement in cancer of the pylorus. Hartmann at once seized upon this basic principle and fixed the point of election for the line of section upon the greater curvature at a healthy place on the gastric wall, to the left of these glands. The distance to the left is regulated by the extent of the disease.

In a previous communication the author called attention to the lymphatic isolation of the dome of the stomach. This has also been noted by Robson and Moynihan. It is evident that the extent of this free zone along the greater curvature is much wider in pyloric cancer than was at that time considered possible. The retention of this portion of the stomach relieves the operation of many serious difficulties without loss of completeness.

Operative detail. The operation itself can be divided into (a) *incision and exposure;* (b) *control of hemorrhage;* (c) *closure of the stomach and duodenal stumps;* (d) *re-establishment of the gastro-intestinal canal;* (e) *avoidance of infection;* (f) *measures for preventing shock.*

The patient's stomach should be cleansed the day before, rather than immediately previous to operation, as it may prove to be somewhat trying to one unaccustomed to the process. A small amount of liquid nourishment may be given after the lavage, but nothing on the morning of the operation. The teeth and mouth should have been previously cleansed as well as possible. A preliminary hypodermatic injection of morphine, to enable the anesthetic to be reduced to a minimum, may be of value.

(A) A small incision is made in the median line, half way between the ensiform cartilage and the umbilicus; through this two fingers are introduced for exploration. If the condition is inoperable, the incision is closed and a sufficient number of buried, non-absorbable mattress sutures of silk, linen or



STOMACH SHOWING DISTRIBUTION OF LYMPH NODES.

As demonstrated by Hartmann and Cuneo.
(From original drawings of Dr. W. J. Mayo.)

wire introduced into the aponeurotic structure of the linea alba to enable the patient to get about at once and to return to his home and friends within a few days. If sutured in the usual manner and the patient placed in bed for two or three weeks, many of them will develop hypostatic pulmonary lesions, loss of appetite, swelling of the feet and so forth, and may be unable to spend

their few remaining days at home. When an advanced cancer case goes to bed for a week or two the chances of his getting about again are small.

Non-absorbable sutures, buried in fixed structures such as fascia and bone, seldom give trouble and furnish immediate strength. In muscle and movable tissues atrophy necrosis may occur. We limit their use, however, to the hopeless cases of exploration for malignant disease. If operation is decided upon, the small exploring incision is rapidly enlarged to four or five inches and a sufficiency of the gastro-hepatic omentum is tied off at once close to the liver. This opens the lesser cavity of the peritoneum and mobilizes the pyloric end of the stomach with tumor. The entire area is now packed off with gauze pads.

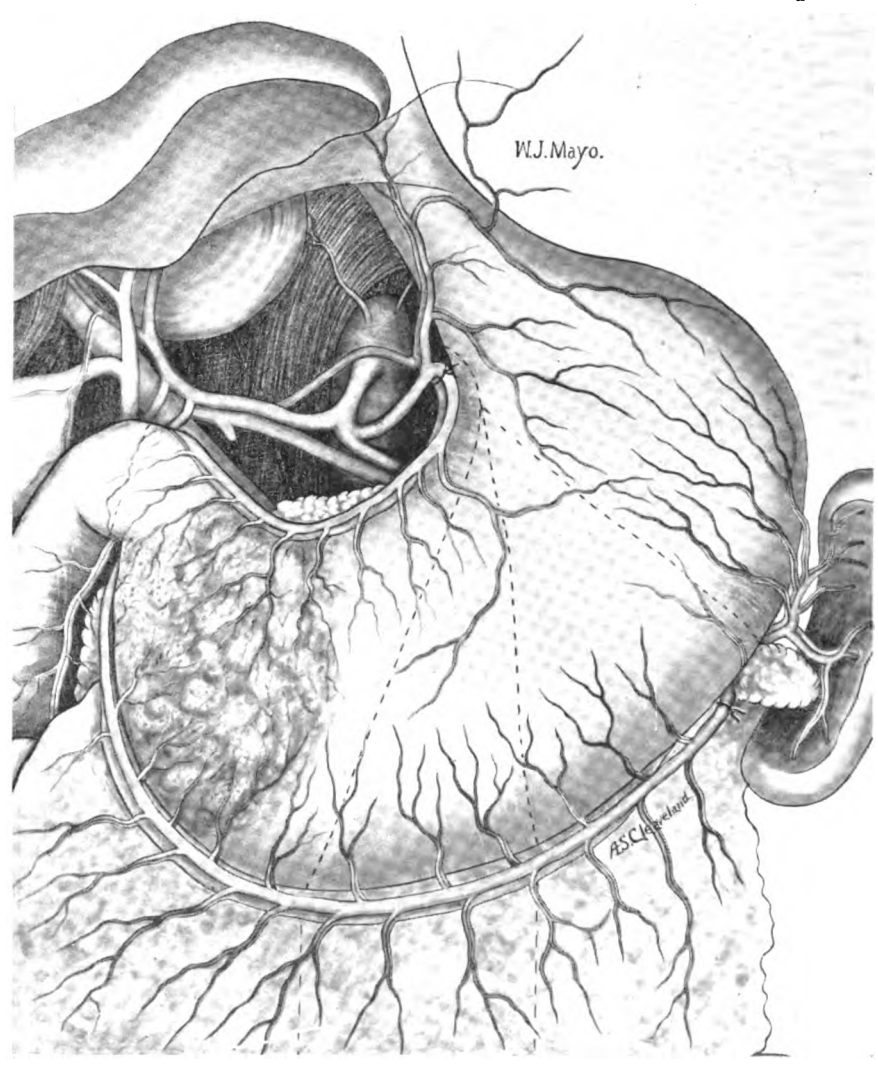
(B) Control of hemorrhage. The pyloric end of the stomach is supplied by four blood vessels, the gastric and superior pyloric above, and the right and left gastro-epiploics below. By ligating these four vessels early the operation is rendered practically bloodless. The gastric is doubly tied about one inch below the cardiac orifice at a point where it joins the lesser curvature, and divided between the ligatures. The superior pyloric is doubly tied and divided. The fingers are passed beneath the pylorus, raising the gastro-colic omentum from the transverse meso-colon, and in this way safe ligation behind the pylorus of the right gastro-epiploic artery, or in most cases its parent vessel, the gastro-duodenal, is secured. The left gastro-epiploic is now tied at an appropriate point and the necessary amount of gastro-colic omentum doubly tied and cut. Sometimes the right margin of the omentum becomes very much congested from the venous obstruction produced in this way. In a few cases it has seemed wise to excise the devitalized omentum, especially if drainage is to be used, with its attendant possibilities of secondary infection. In one such case a considerable amount of omentum tissue sloughed, although fortunately the patient recovered. If drainage is not used it will act as an omental graft and give no trouble. It is important that in ligating the gastro-duodenal vessel and the gastro-colic omentum the fingers should raise the structures away from the middle colic artery which runs immediately beneath in the transverse meso-colon.

The lesser cavity of the peritoneum is a potential rather than an actual space, as the two layers of peritoneum are in contact, and the middle colic has been accidentally caught in tying the vessels from without inward. As this vessel usually is the entire supply of the transverse colon ligation may result in gangrene of the transverse colon, as pointed out by Kronlein. This has happened a number of times.

The control of hemorrhage is very similar to the ligation of the four vessels concerned in abdominal hysterectomy and fully as easy.

(C) The duodenum is doubly clamped and divided between with the actual cautery to prevent inoculation of the cut surfaces with cancer. The stump should be left one-fourth inch long, and before removing the clamp a running suture of catgut is introduced through the seared stump and tied as the clamp is removed. A purse-string suture of silk or linen three-quarters of an inch below the stump, enables inversion in a similar manner to the stump of the appendix. A long Kocher clamp is now placed from the tied gastric artery at Mikulicz's point of election, in an oblique direction, so as to save as much as possible of the greater curvature to Hartmann's point of election on the greater curvature. The blades of this clamp should be covered with rubber tubing and the compression should be just sufficient to retain the tissues in its grasp. A second clamp is applied on the tumor side to prevent leakage. The tissues between are severed with the Paequelin cautery, one-quarter of an inch from the holding clamp, and as the tissues are divided several catch forceps are applied to the projecting stump to prevent retraction of some part

of the gastric wall from the grasp of the Kocher clamp. The pyloric end of the stomach, with the tumor guarded against leakage by the clamp at each end, is removed. The cauterized stump projecting beyond the Kocher clamp is rapidly sutured with a catgut button-hole suture, from the greater to the



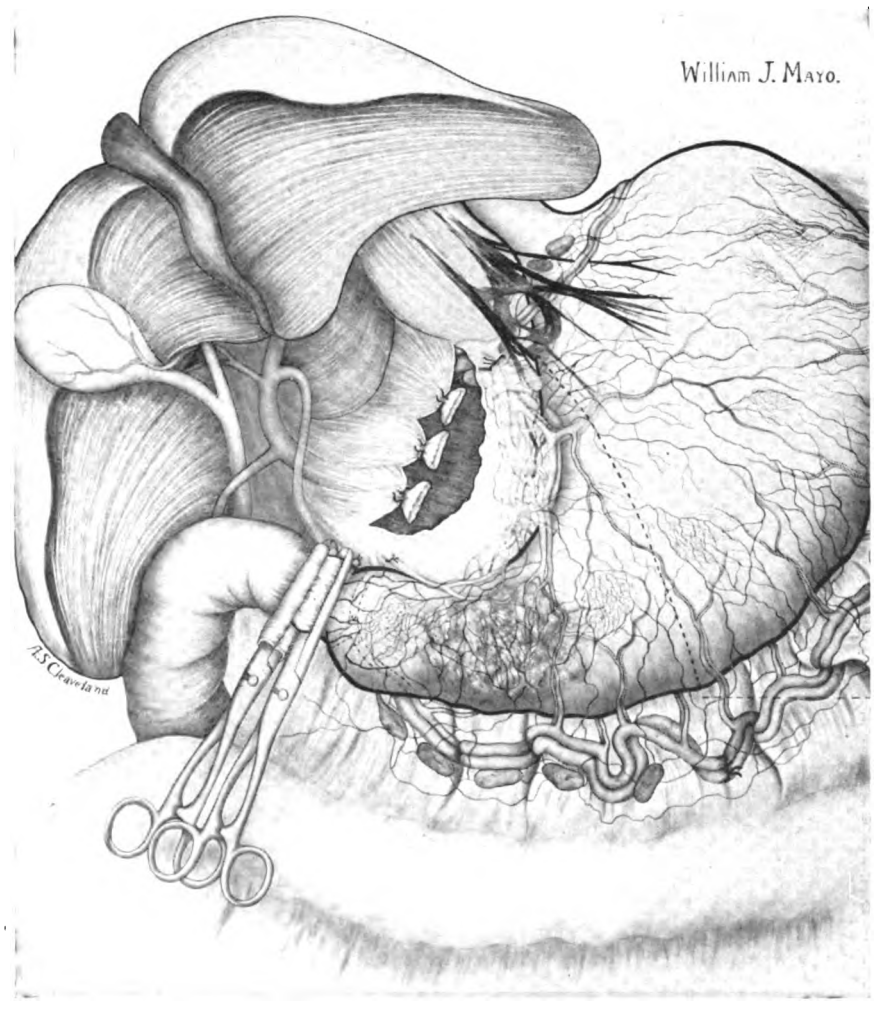
STOMACH WITH CARCINOMA OF PYLORUS.

Showing lines chosen in making pylorectomy or partial gastrectomy by various surgeons. (From original drawings of Dr. W. J. Mayo.)

lesser curvature, through all the coats of the stomach, and in the same manner directly back, and tied at the starting point; this prevents hemorrhage as well as leakage. The doubling of this form of suture holds the approximated edges evenly in line. The Kocher clamp is now removed and any bleeding point caught and tied.

The final suture, of silk or linen, is now introduced and made after the right-angled plan of Cushing. It is taken sufficiently far from the catgut suture line to enable easy approximation of the sero-muscular layers without tension.

Steps (d) and (c) can be varied sometimes to advantage. We have fre-



STOMACH WITH CARCINOMA OF PYLORUS.

Showing manner of applying forceps to duodenum and also ligation of lesser omentum. Also showing lymph nodes usually involved and line of excision in early cases.
(From original drawing of Dr. W. J. Mayo.)

quently tied off the gastro-hepatic ligament and the superior vessels and at once double clamped and divided the duodenum. By pulling upward on the stomach side the gastro-duodenal artery is easily caught, tied and divided, and the operation proceeded with as before. In a few cases we have begun on the stomach side, ligating and dividing the gastric and left gastro-epiploic vessels first, then clamping, dividing and suturing the stomach as before, complet-

ing the duodenal end with its vessels last. This is favored by Hartmann. If there are adhesions, however, the first plan mobilizes the stomach much better and enables more accurate work and greater exposure of that part of the stomach, which, at the line of section, lies naturally deep under the costal arch.

(D) Restoration of the gastro-intestinal canal was first accomplished by Billroth, by joining directly the cut surface of the duodenum to the shortened stomach, the opening of the latter viscus being partly sutured to reduce it to the size of the duodenal end. The angle where the three suture lines come together leaked so often, especially if there was the least tension, that it was called the "fatal suture angle." Kocher saw the defect in this method and began implanting the cut end of the duodenum to the posterior gastric wall at a sound point, and completely closed the stomach. This method gives excellent results, if there be no tension in bringing the parts into easy apposition. Unfortunately this often happens.

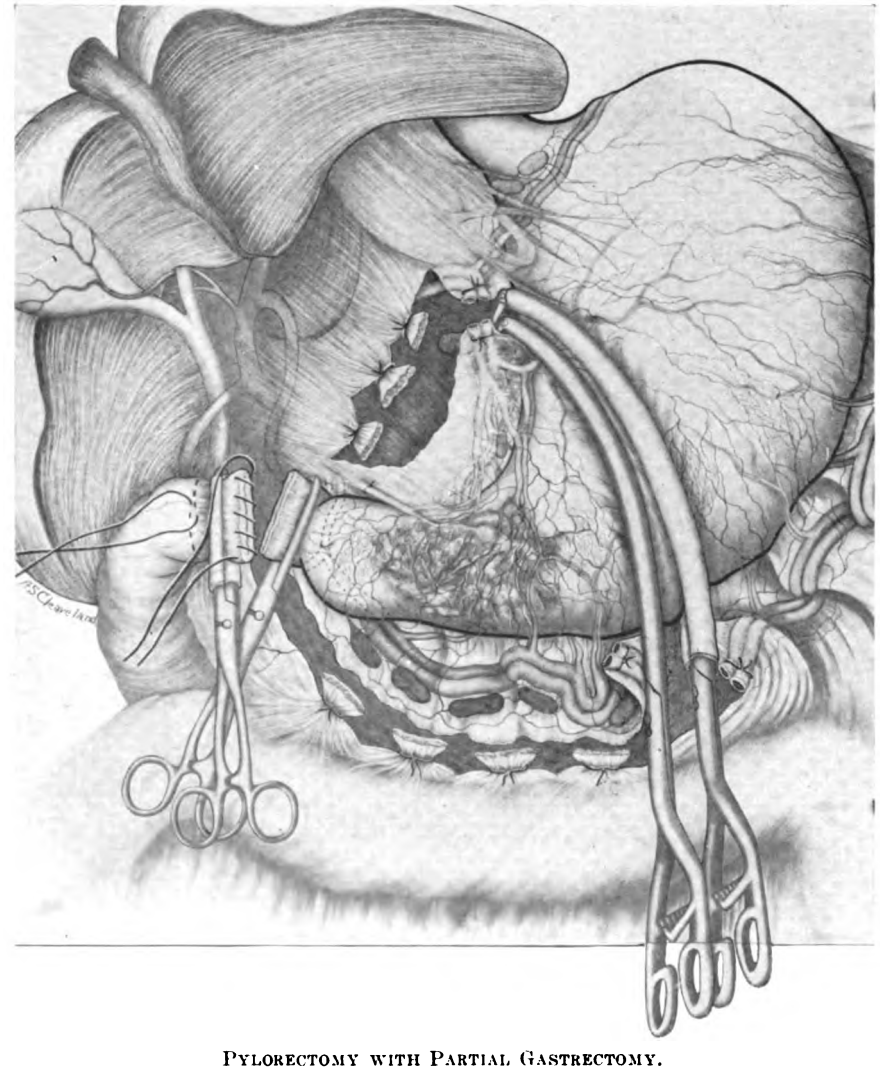
Billroth's second operation is the operation of choice:—Complete closure of the duodenal and stomach ends with an independent gastro-jejunostomy of the usual type. It has the two chief requisites of gastro-intestinal anastomosis; there is no tension and the parts to be united have not been injured. Either the anterior or posterior method can be used and the Murphy button or suture operation be performed. If the patient is in good condition and the operation has been completed promptly, we prefer the posterior suture method; if the patient's condition is poor, the anterior button operation is chosen.

(E) Infections. The question of cancer infection grafted upon a raw surface is an important one. We have seen carcinomatous nodes develop in the abdominal incision, and in the abdominal needle puncture made in suturing the abdominal wall after partial gastrectomy. Dissemination of carcinoma by rough handling or allowing infected cells to escape into the wound is not uncommon. It is for this reason that all sections of the diseased parts are made with the actual cautery, which prevents inoculation of raw surfaces, checks capillary hemorrhage and leaves the approximated ends in an aseptic condition until they are digested back to the outer suture line. Pyogenic infection is prevented by the clamps placed upon each side of the excised stomach, sealing against escape of contents, while the exposed edges beyond the clamp are sterilized by the use of the cautery in making the section. In addition to this the gauze pads are arranged in two rows, an outer, deep layer which is not changed until final removal, and an inner, superficial layer, which is being constantly renewed. Upon removal of the final gauze pack the entire field is carefully gone over and any little bleeding point checked by ligature. After sponging the surfaces with a moist saline gauze pad, the abdominal incision is closed.

In some cases drainage seems wise on account of accidental soiling. This is seldom necessary but if in doubt, drain, and best with a cigarette drain placed at the lower angle of the external wound, entirely away from the visceral suture lines. The internal end of the drain should reach to a situation just above the transverse colon, which acts as a dam when the patient is placed in the proper position in bed—head and shoulders elevated. In this half-sitting posture the little pouch formed by the transverse colon is not unlike an artificial pelvis into which any fluids gravitate. If there be but a limited area to be quarantined, as from slow perforation, the drain should be brought out in the most direct manner possible.

(F) Shock. If the patient is in good condition there is practically no shock because there is no blood loss and little exposure of abdominal contents. The operation proceeds systematically and can be done in a suitable case by the average operator, from the beginning of the abdominal incision until it is

closed, in from fifty minutes to one hour and fifteen minutes. If the patient's condition is very poor, owing to early obstruction, the chief danger comes from the lack of fluids in the body. As suggested to us by Dudley Allen, this should be made up by subcutaneous infusions of saline solution, forty

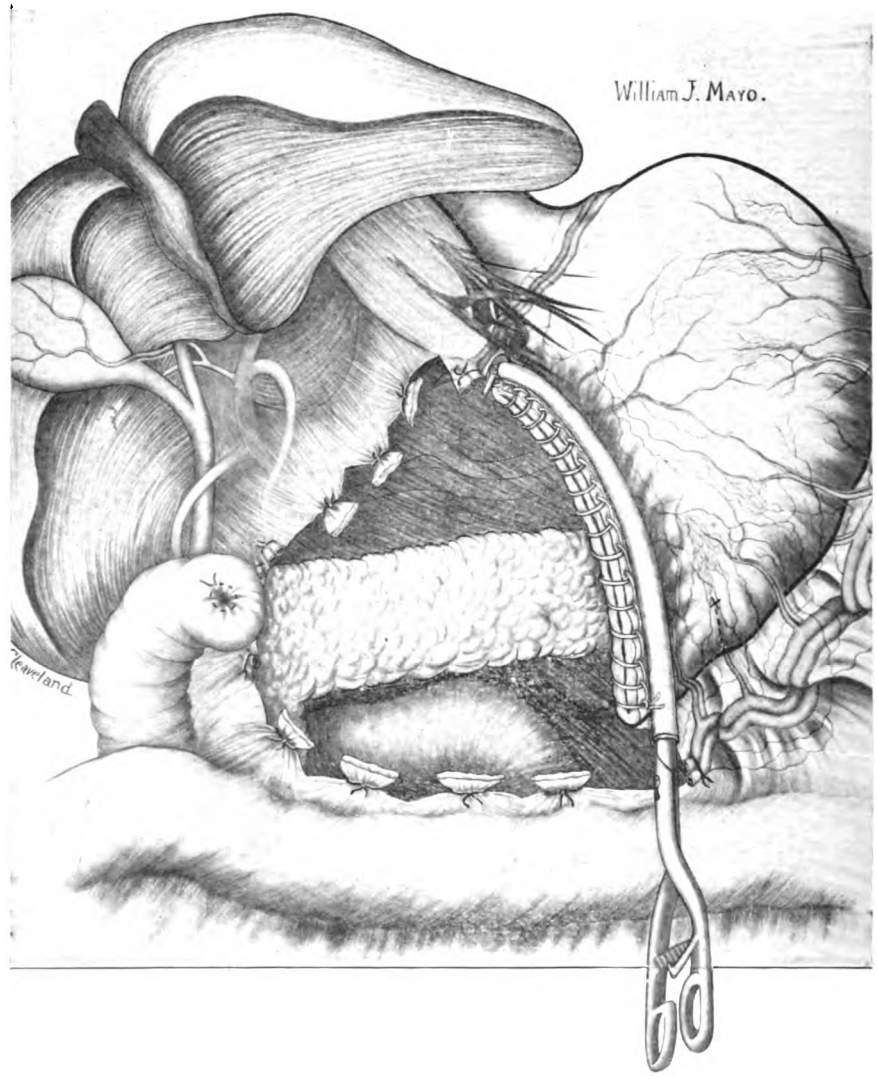


PYLORECTOMY WITH PARTIAL GASTRECTOMY.

Showing ligation of lesser and greater omentum, also application of clamps to duodenum and to stomach. Also circular and end-sutures of duodenum in place.
(From original drawings by Dr. W. J. Mayo.)

to sixty ounces a day, usually twenty to thirty ounces every twelve hours, for two days previous to the operation. This is continued for several days following operation if necessary. In these dehydrated patients it is almost impossible to get sufficient fluids into them in any other manner. For subcutaneous infusions we prefer the ordinary Davidson syringe, to which I attach an aspirating needle. The hand bulb enables nice regulation of the

inflow. The whole can be boiled and the infusion given by a nurse as easily as an enema. In debilitated patients very little anesthetic is used, just enough to enable the surgeon to open and close the abdomen. All of the



PYLORECTOMY WITH PARTIAL GASTRECTOMY FOR CARCINOMA OF PYLORUS.

Showing manner of closing end of pylorus and stomach, also ligation of all vessels. (From Dr. W. J. Mayo's original drawing.)

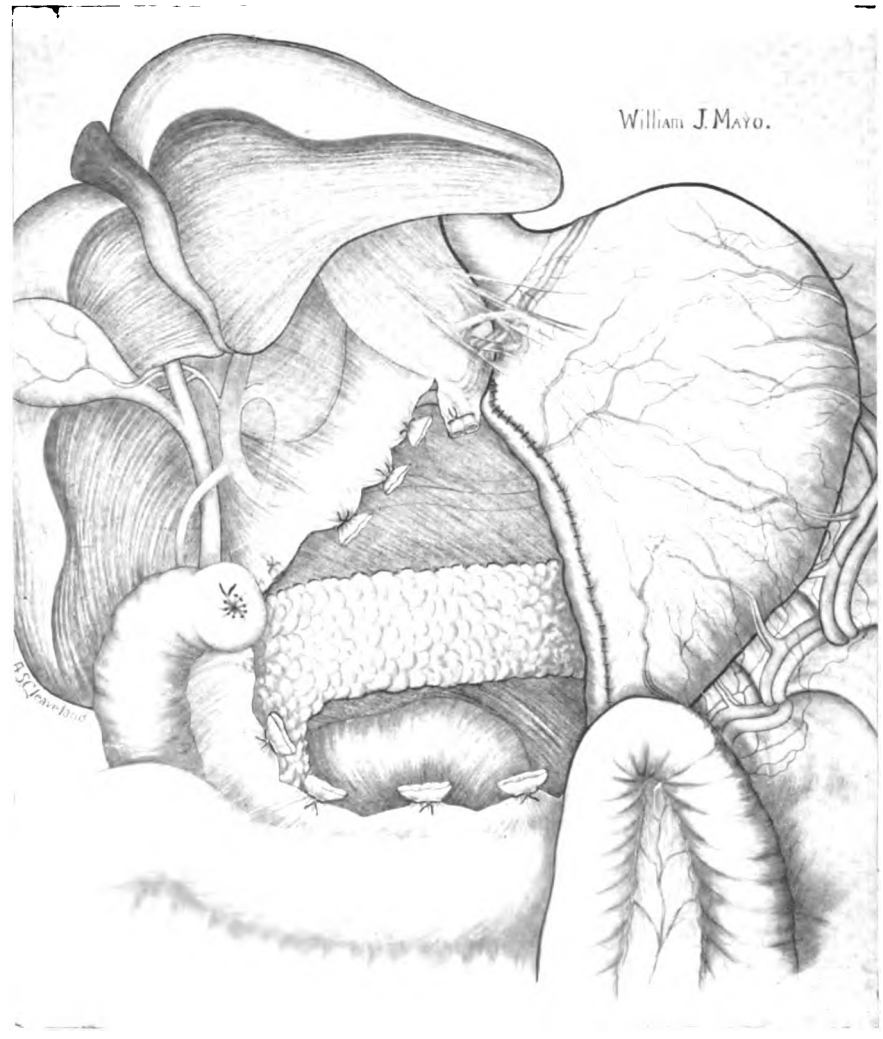
visceral work can be done without pain. The previous exhibition of morphia keeps the patient from becoming nervous.

An enema of six ounces of coffee is given as soon as the patient is put to bed. If necessary morphia, strychnine and so forth are exhibited.

The after-treatment is simple, the head and shoulders of the patient are

raised by four or five pillows, rectal alimentation is instituted, hot water by mouth, after twelve hours, in tablespoon doses, increased to an ounce every hour. After thirty-six hours the usual experimentation with liquid foods is begun.

To recapitulate, there are six important stages to the operation as outlined:



PYLORECTOMY WITH PARTIAL GASTRECTOMY WITH GASTRO-JEJUNOSTOMY OPERATION COMPLETED.

(From Dr. W. J. Mayo's original drawing.)

Step 1.—Open the abdomen.

Step 2.—Double ligate and divide the gastric artery, ligate and divide the necessary amount of gastro-hepatic omentum close to the liver, leaving most of its structure attached to the stomach. Double ligate and divide the superior pyloric artery and free the upper inch or more of the duodenum.

Step 3.—With the fingers as a guide underneath the pylorus, in the lesser

cavity of the peritoneum, ligate the right gastro-epiploic or gastro-duodenal artery and progressively tie and cut away the gastro-colic omentum distal to the glands and vessels up to the appropriate point on the greater curvature, and here ligate the left gastro-epiploic vessels.

Step 4.—Double clamp the duodenum, divide between with the cautery, leaving one-fourth inch projection. With a running suture of catgut through the seared stump the end of the duodenum is closed as the clamp is removed. A purse-string suture about the duodenum enables the stump to be inverted. The proximal end of the stomach is double-clamped along the Mikulicz-Hartmann line and divided with the cautery, leaving one-fourth inch projection. Suture through the seared stump with a catgut button-hole suture. This is again turned in after removal of the clamp by a continuous silk or Cushing suture.

Step 5.—Independent gastro-jejunostomy.

Step 6.—Closure of the wound.

The operation herein described, with a mortality of one in fifteen should be the operation of choice for the average case of fairly early disease of the pyloric region.—W. J. Mayo, A. M., M. D.]

GASTROPTOSIS

The condition of gastroptosis is rarely found except in a complicated form. It is usually associated with a condition of general enteroptosis in which all of the intra-abdominal organs are more or less prolapsed. Thus, for example, when the patient is in the erect position the liver is below the normal line; the kidneys, especially the right one, are lower than normal; the transverse colon, cecum and small intestines are low down in the abdomen. Several years ago many of these patients were subjected to a gastro-enterostomy, in the hopes that gastric drainage might relieve their stomach disturbances, but the results were most unsatisfactory.

Patients suffering from gastroptosis are usually thin and are often tall and nearly always of a nervous temperament. They complain of chronic stomach trouble characterized by discomfort after eating, bloating and eructation of gas. Nausea and vomiting are not uncommon, and usually a stomach splash can be found in the lower portion of the abdomen several hours after eating. Constipation is usually present.

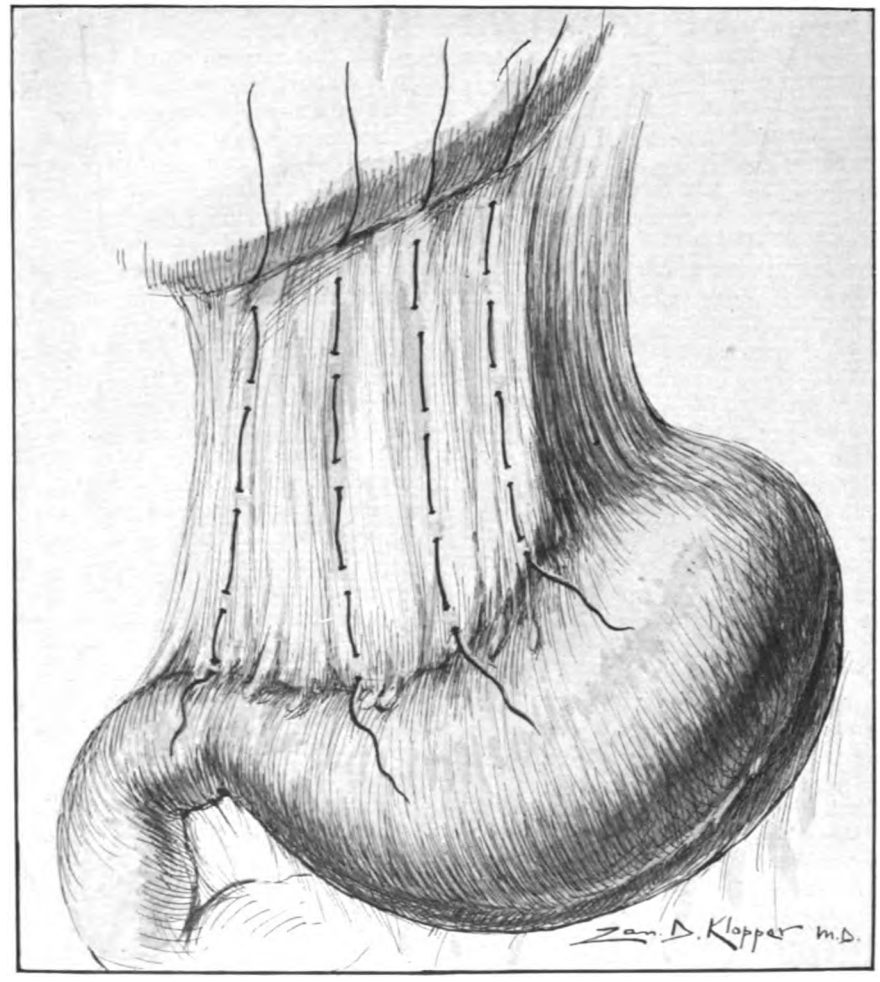
The physical signs of gastroptosis can easily be elicited by distending the stomach with air through a stomach tube, or by administering a bismuth meal and taking an X-ray picture.

Treatment. The majority can be greatly benefited by general treatment, such as regulating the bowels; massage of the abdomen; gymnastic exercises to strengthen the abdominal wall; the avoidance of tight lacing; the administration of tonics; giving a simple but nourishing diet. Much benefit may also be derived by supporting the abdominal viscera by the wearing of a well-fitting abdominal support.

In many patients the palliative treatment does not give relief and they become emaciated, suffer constantly and become chronic invalids. In these we have to look to some surgical procedure for relief. The object of the operation is to place the stomach in its normal location as nearly as possible and retain it in this position. This will do away with the dragging on the gastro-hepatic omentum and overcome the obstruction which is usually present due to a kinking of the duodenum.

Operative treatment. Many operations have been devised for holding up the stomach, but that of Beyer seems to be the most satisfactory. He shortens the suspensory ligaments of the stomach without interfering with its normal

mobility and no abnormal attachment is made to the abdominal wall. The operation is performed as follows: The patient placed in the inverted Trendelenburg position, and a median incision is made allowing the intestines to settle toward the lower portion of the abdominal cavity. The sutures used should be of some non-absorbable material, as linen or silk. The first suture is



SHOWING APPLICATION OF STITCHES IN THE GASTRO-HEPATIC OMENTUM IN BEYER'S OPERATION FOR GASTROPTOSIS.

introduced, beginning above, in the strong tissue of the attachment of the ligament to the liver, the needle grasping a considerable bite of tissue, then grasps the more delicate portion at short intervals from above downwards until a point just above the gastric vessels is reached at the lesser curvature. Four to six of these sutures are inserted in this manner as shown in illustration. When these sutures are tied the lesser curvature is carried up in contact, or almost in contact, with the under surface of the liver at the attachment of the gastro-hepatic ligament, and is fixed in this position.

The principle of this operation is that by placing interrupted sutures from above downward through the gastro-hepatic omentum, or gastro-hepatic and gastro-phrenic ligaments, the normal ligamentary supports of the stomach are shortened and the stomach elevated to its normal position without disturbing the physiologic mobility of the organ. With the elevation of the stomach the ptosis of the transverse colon is somewhat corrected.

After-treatment. After the operation gastric lavage should be used once or twice a day during the time the patient is in the hospital, and nourishment should be given in the form of concentrated food in small quantities to prevent any gaseous distension of the stomach until the tissues have become firmly fixed. With the stomach in this new position, the condition for normal digestion will be greatly improved, and within a few months the patient's nutrition should be markedly better. Among these patients there are many who suffer from a general neurotic condition, and unless this be due to malnutrition resulting from the gastroptosis, the neurotic state will not be much benefited.

Rovsing's operation. Rovsing's operation consists in fastening the anterior wall of the stomach to the anterior abdominal wall at as near its normal position as possible.

A median incision is made from the ensiform cartilage to the umbilicus. The stomach is delivered into the wound, and its anterior wall is grasped by four mouse-toothed forceps, one forcep being applied to the edge of the lesser curvature about six cm. from the pylorus, the second one to the lesser curvature about ten cm. distant from the first, and the other two being applied at corresponding points near the edge of the greater curvature. The parallelogram formed by these forceps indicates the portion of the stomach to be fastened to the abdominal wall. A heavy silk suture is now inserted at the point of the upper forcep on the lesser curvature and carried along the lesser curvature to the point of the other forcep near the pylorus. This stitch picks up the peritoneal and muscular coats of the stomach at intervals of one cm. Four similar sutures are applied along the anterior wall of the stomach parallel to the first one, the last extending between the two forceps on the greater curvature. These sutures are now passed up through the abdominal wall on the abdomen, the sutures from the cardiac end of the stomach emerge from the abdomen about seven cm. to the left of the median line and the others about three cm. to the right. The sutures are so placed that those to the left side are at a higher level than those from the pyloric end of the stomach, this will attach the stomach in a slanting position downwards from left to right. The peritoneal surface is now slightly scarified and the abdominal incision closed. A glass plate about ten cm. square is wrapped with sterile gauze and placed opposite the stomach and the five silk sutures are tied together across this plate. These sutures are left in place about three weeks.

The authors have performed the Rovsing operation in three cases in which it was possible to make fluoroscopic examinations at various intervals. In two of these cases the former condition of gastroptosis had recurred within one year after the operation. In the third case, the stomach has remained in good position during a period of three years.

PART VII

SURGERY OF THE GALL BLADDER AND LIVER

In considering the etiology of gall bladder disease it is important to bear in mind the anatomical relations and the mechanical provisions. So long as the anatomical relations are normal, and the organ is, mechanically considered, approximately perfect, there is no occasion for treatment because the gall bladder becomes distended with bile, which is a non-irritating fluid and is emptied regularly. These functions give rise to neither pain, irritation or discomfort.

Normally the gall bladder is suspended from the under surface of the liver as a very slightly distended, pyriform sac which empties its fluid rapidly into the duodenum. The muscles of the gall bladder are very active and well able to expel the contents.

Function. The theory that the gall bladder serves the purpose of collecting bile during the intervals between the taking of food, and that this bile is then forced into the duodenum during the time that the food passes from the stomach through this organ, has been questioned of late because of the fact that no satisfactory proof has been produced for this theory, because of the fact that patients whose gall bladders have been removed surgically do not suffer in any way because of its absence, and because of the further fact that the amount of bile that can be accumulated in the gall bladder is very small compared with the amount of bile that is secreted during the time the food passes through the duodenum.

These arguments and others have been advanced with an air of scientific superiority overlooking the point that it is quite logical to consider our inability to recognize definite proofs of a function as a valid reason for disputing a function. Consequently, it seems far more scientific to await further research before we accept the theory that the gall bladder has no value from the standpoint of physiology.

Etiology. It seems to have been proven beyond a doubt that this pouch shares the fate of all similarly constructed organs in the body—the stomach, the urinary bladder, the pelvis of the kidney, the vermiform appendix; so long as there is nothing to prevent these organs from emptying their contents they are almost certain to remain normal, but so soon as obstruction occurs, interfering with the natural drainage of the organ, trouble is likely to ensue. In other words, an interference with drainage is sure to cause a certain amount of residual substance which makes the accumulation of bacteria possible, and from this accumulation we must expect injury to the lining of the gall gladder.

In ordinary health it is probable that in the majority of cases the human bile is sterile. The bile remains sterile, however, only as long as it flows unobstructed through the ducts. It has been shown experimentally that as soon as the outward flow of bile has been obstructed by ligature of the common duct, the bile above the obstruction becomes infected.

Bacteria enter the gall bladder chiefly in two ways: 1. Along the common duct from the duodenum. 2. By the blood current, chiefly from the

portal vein. The bacillus coli, the typhoid bacillus, and the streptococcus are the most common bacterial inhabitants of the gall bladder and of gall stones.

The injury that results from the accumulation of bile in the gall bladder may simply be catarrhal at first, but will later become destructive to the mucous membrane, giving rise to ulceration; this in turn will result in cicatricial contraction, and this in further obstruction. In such manner the condition must progress.

In the meantime the mucous and débris in the gall bladder may have been moulded into gall stones by contraction of the gall bladder and thus give rise to another important element. The lining of the gall bladder is now no longer in contact only with the relatively non-irritating bile, but also with these hard bodies, which are often of very irregular form, consequently having sharp angles or projections.

The location of the impacted stone can frequently be determined from the symptoms. If the increase in pain is accompanied by a chill, the impaction is usually lower than the neck of the gall bladder. A stone impacted in the neck of the gall bladder may cause a distension of the gall bladder with serum more or less purulent in character. A gall bladder under this condition may acquire a large size, although usually this distension itself causes the stone to become dislodged and to fall back into the gall bladder, and thus permits the bile to be evacuated through the cystic duct. But as long as the stone is not impacted in the cystic duct or in the common duct, a chill is not likely to occur, because the infection accompanying the impaction does not reach any of the lymph nodes which are located farther down. If the stone is located in the cystic duct or in the common duct there is likely to be a fairly high leucocytosis.

Clinical experience has shown that the above theory is correct, because in most of our cases there has been a distinct interference with drainage of the gall bladder. In many cases this was caused by a drawing down of the viscus by adhesions to the omentum or transverse colon, or both, probably caused by a peritonitis resulting from a perforative appendicitis which the patient had sustained many years before. In other cases there was a pedunculated gall bladder, which has been attributed to the effects of tight lacing, and as in many cases this condition occurred only in women, it seems possible that this view is correct.

Concomitant conditions. It has been found that bacteria, especially the colon bacillus, are present with great regularity in diseased gall bladders and in gall stones. It has been found that a large proportion of gall stone patients previously suffered from typhoid fever, and we have found that more than thirty-five per cent. of our cases suffered from acute or chronic appendicitis. It is difficult to determine whether typhoid fever, disease of the gall bladder, and of the appendix in appendicitis, is simply a simultaneous infection or whether the infection of the gall bladder is secondary to the other infections.

In experiments upon animals it has been found that the simple infection of the gall bladder gives rise to no pathological condition, provided there is no obstruction to the biliary or cystic duct. The constant flow of new bile seems to be sufficient to dilute and wash away the infectious material to a sufficient extent to make the infection harmless.

Obstruction. It is quite different as soon as there is an obstruction to the ducts. Where there is residual bile in which micro-organisms can multiply, a pathological condition will ensue which may simply develop into a catarrhal inflammation of the mucous lining of the gall bladder, or it may result in the formation of gall stones, or in a severe inflammation of the gall bladder involving anatomical structures beyond the mucous membrane. In man this obstruction may result from the inflammation of the mucous membrane of

the common duct due to an infection from the alimentary canal, or, as we have seen in a number of cases, the gall bladder may be drawn downward by adhesions, causing a short bend in the common duct, or more usually in the cystic duct; or an adhesion between the duodenum, stomach and liver. This condition is often due to a gastric or duodenal ulcer. Again, the gall bladder may be forced down out of its normal position on account of tight lacing, and the mucus and débris, accumulated in the pouch containing residual bile, may be expelled at intervals and may clog the biliary or the common duct, and thus form the obstruction necessary to make the infective material effective. We have repeatedly observed a complete obstruction of the common duct produced in this manner. Moreover, we have observed some of the most violent paroxysms of gall stone colic in cases of this kind.

If this obstruction persists in the presence of infectious material in the gall bladder a suppurative inflammation may ensue and this may result in an empyema of the gall bladder; if the infection is severe, especially if there be present a spasmodic contraction of the gall bladder, the entire mucous lining of the latter may become gangrenous, a condition which we have repeatedly seen in acute cases. This may in turn extend to the other layers of the gall bladder, resulting in a gangrene of the entire organ, or it may affect only a small portion of the gall bladder. When this is the case, the contraction of the non-affected portion of the gall bladder is likely to cause a perforation at the gangrenous point.

It is of practical importance to know that these spasmodic contractions of the gall bladder correspond with contractions of the stomach and that they will subside when the stomach is at rest, only to recur when this condition of rest in the stomach is interrupted.

Age and sex undoubtedly have some influence upon the formation of gall stones, most often found in middle adult life. In looking over a series of several hundred of our own cases it was found that the average age at the time of operation was forty-six years, and that the average duration of symptoms as given in the histories was six and one-half years. The condition occurred four times oftener in females than in males. The youngest male patient operated upon by the authors was twenty years of age, and the youngest female was ten years old.

Symptoms and signs of gall bladder disease. The frequency with which gall stones are overlooked draws our attention to the fact that it will be necessary to change the basis of our diagnosis, because the old plan must continue to result in wrong conclusions.

In studying the histories of a series of gall stone cases it will be found that the early manifestations of the presence of gall stones will practically never be referred by the patient to the region of the gall bladder or bile ducts. The patients refer their trouble to the region of the stomach and not to the liver.

Perhaps the earliest symptom, which has persisted for years, is "indigestion." It is not uncommon for these patients to come to the surgeon with a diagnosis of an attack of indigestion, gastric catarrh, neuralgia of the stomach, spasms, etc.

The symptoms, complications and dangers of gall stones differ greatly according to the location of the stones in the gall bladder, cystic or common ducts.

Gall stones in the gall bladder, in the absence of infection, may produce so little discomfort that they may persist for years without being discovered. As soon as catarrh or some acute infection occurs, or the stone passes from the gall bladder into the cystic duct, there may be a great variety of

symptoms, varying from mere spasms, frequently called attacks of "indigestion," to very severe colic, agonizing in character, so severe as to even lead to collapse.

Pain to be distinguished from colic may be local or referred. The local pain may be dull in character, rather diffuse, and exaggerated upon taking food. It is this variety of pain which is apt to be mistaken for that due to disease of the stomach. The dull pain is usually due to some irritation or inflammation of the gall bladder becoming more or less tense by some obstruction to the cystic duct due to an impaction of a stone in the cystic duct in its attempt to escape from the gall bladder, or to an inflammatory state of the gall bladder interfering with the free exit of bile.

An important sign. Tenderness is always present especially on deep pressure. One of the most constant signs of gall bladder disease is the inability of the patient to take a full inspiration when the physician's fingers are placed up underneath the costal arch in the region of the ninth or tenth ribs. The diaphragm forces the liver down until the sensitive gall bladder reaches the examining fingers when the inspiration suddenly ceases as though it had been shut off.

The pain is frequently more acute than that described above, which means that there is a more marked irritation and inflammation of the gall bladder or its ducts, and perhaps of the surrounding peritoneum.

The pain may be referred to various regions. It frequently radiates to the right subscapular region and occasionally to the left; to the epigastric region or umbilicus; to the front of the chest and neck or down the arm.

Boas has described the existence of an area of referred tenderness which is present in the majority of patients suffering from gall bladder disease.

To demonstrate this area the finger should be pressed against a point to the right of the tenth dorsal spine; then against successive points in lines running horizontally outwards, opposite the other spinous processes. It will then be evident which side, if either, is the more tender.

Colic. Colic in gall stone disease is not as common as formerly supposed We have found that over one-half of our cases have never experienced severe biliary colic.

The colic, when severe, causes the most intense suffering. It comes on suddenly and not infrequently produces a condition of collapse. The patient is cold and yet has profuse sweating.

The location of the pain differs greatly. When the colic is due to a spasm of the gall bladder or cystic duct it is most apt to begin along the right costal margin and radiate to the right subscapular region. When due to spasm of the common duct it is more apt to be located centrally and radiate to the mid-scapular region. It may be epigastric throughout, or may even be situated in the left upper quadrant of the abdomen.

The cause of gall stone colic has been much discussed, yet there seems to be no present agreement upon this subject.

Considering the abruptness with which these colics begin, and the suddenness in their relief, it would seem more probable that the pain was due to a spasm of the gall bladder or its ducts during the attempt at expulsion of a calculus, or thick bile, sand or mucus. This suddenness with which the pain begins and subsides is certainly incompatible with anything of an inflammatory nature, and can only be explained by a spasm due to the sudden entrance and exit of some foreign body.

Coincidence between stomach and gall bladder contractions. It is of practical interest to know that these spasmodic contractions of the gall bladder correspond with the contraction of the stomach and that they will subside

when the stomach is at rest, only to recur when this condition of rest in the stomach is altered.

We have repeatedly observed that attacks of gall stone colic, which would not subside from the use of as much as one-half to three quarters of a grain of morphine given hypodermically, stop directly upon irrigating the stomach with very hot water, thus putting the organ at rest, only to have a recurrence the moment any form of food was taken, giving rise to the normal contraction. In these cases a renewed use of gastric lavage and further abstaining from food would result in permanent interruption of the spasmodic contraction of the gall bladder. This point is of practical importance, because it not only indicates an efficient means for securing the relief of pain, but also for preventing destruction of gall bladder tissue and possible perforation.

Stomach symptoms. Perhaps the most common, as well as earliest symptom of gall stone disease is "indigestion." The attacks of indigestion begin with pain in the epigastrium, followed by nausea and finally vomiting, which usually brings relief. The nausea and vomiting are partly reflex in character and partly due to direct irritation.

Other gastric disturbances associated with gall bladder disease are frequently manifested by distress in the epigastric region, described as a feeling of weight or a burning sensation after eating; also gaseous distension of the abdomen. These patients are also usually troubled with eructations of gas after eating. It is not uncommon for these patients to have repeated attacks of nausea and vomiting and attacks of indigestion accompanied by a severe pain in the epigastrium, often called gastralgia or neuralgia of the stomach.

After an attack of nausea, vomiting and epigastric pain there is apt to be an interim when the patient is free from stomach symptoms, or has only the milder symptoms of bloating and distress after eating.

There may be a dull pain beginning in the epigastric region and extending around the right side at about the level of the tenth rib, passing to a point near the spine and progressing upwards underneath the right shoulder blade.

Jaundice. This condition, upon which so much stress has been placed in the diagnosis of gall stones, is absent in the greater number of cases. Our experience has been that only a small proportion have ever been severely jaundiced, and in more than one-half of them jaundice has never been observed.

The idea in regard to icterus in connection with gall stones has been handed down to successive generations of physicians and the laity so long, that the majority of patients refuse to believe that they could have gall stones and not be jaundiced.

Jaundice in cholelithiasis is due to an impaction of a stone in the common or hepatic ducts, or an infection of these ducts, and occasionally to an impaction of a large stone in the cystic duct pressing upon the common or hepatic ducts.

When jaundice is due to gall stones it is most always preceded by a colic. The colic may come on a few hours or days before the appearance of the jaundice. The yellow tinge as a rule comes on gradually and increases until the obstruction is relieved, and then gradually disappears.

Remittent icterus, slight, or as might be called, incomplete attacks of icterus, occurring as often as once or twice a week, is characteristic of stone in the common duct. Fenger attributed this condition to a floating choledochus-stone. He described this condition as occurring in the following manner: A stone becomes impacted in the common duct, and the accumulation of bile on the proximal or liver side, presses the walls of the duct away from the stone, allowing the bile to pass around the stone. Following this the remittent jaundice is due to a "ball-valve" action of the stone.

When jaundice is due to a carcinoma involving the gall ducts, or from

pressure from a growth of the head of the pancreas, the jaundice will appear gradually and without pain. There will be no remission or intermission, but it will steadily deepen from day to day until the skin becomes a greenish-yellow color. It is very rare to meet with jaundice of a deep, greenish-yellow color, except in the presence of malignant disease.

Fever is not ordinarily present early in a simple attack of gall stones. If the attack is prolonged and infection occurs, temperature develops. When the infection is confined entirely to the gall bladder, the rise of temperature is usually not high. Mayo explains this condition by the fact that there are few lymphatic channels in the gall bladder and consequently slow absorption.

Where there is an infection of the ducts there may be rigor accompanying or following the colic, with a very abrupt rise of temperature to its maximum, and then with almost equal rapidity a return to normal. These attacks may simulate a malarial infection. Between the attacks of infection the temperature remains practically normal. Persistent fever associated with other gall stone symptoms may mean an empyema, or severe cholecystitis or an extension of the infection to the channels in the liver.

Tumor. A palpable enlargement of the gall bladder occurs as the result of some obstruction of the cystic duct. This obstruction may be from an impacted stone, a cicatricial contraction of the cystic duct, a twist of the neck of the gall bladder, or from an abnormal growth. It occurs also when there is an obstruction of the common duct caused by some pressure from outside.

An enlarged gall bladder is generally pear-shaped, lies just below the edge of the liver and moves up and down, during the act of respiration, with the liver.

Occasionally, through a relaxed abdomen, one can directly palpate the stones within a gall bladder.

Diverticulum of the gall-bladder perforating the liver. Anomalies of the gall-bladder are comparatively rare and but very few references to such cases can be found in the literature. An anomalous gall-bladder complicated with disease and, necessitating a surgical removal, was recently encountered in our clinic.

In Piersol's "*Human Anatomy*" the following statement is made regarding abnormalities of the gall-bladder: "The gall-bladder may be absent, as is normally the case in some of the lower animals; it may be congenitally of hour-glass shape; it may be bifid; it may communicate directly with the liver by an hepatocystic duct; or it may be transposed in conjunction with other viscera."

Rolleston, in his monograph on "*Diseases of the Liver, Gall-Bladder and Bile-Ducts,*" mentions several anomalies and gives a reference to F. Dévé. The latter author is the only one, so far as we could determine, who has described a condition similar to the case which follows.

A Finnish housemaid, age twenty-nine, was admitted to the hospital on September 1st, 1916. Her family, past and menstrual histories were negative. She had had measles as a child and does not think she ever had any other illness. She was never injured. In December, 1915, the mastoid cells on the right side were drained, and the tonsils were removed.

Present complaint. In July, 1916, she had an attack of pain in the right lower quadrant which was transmitted to the epigastrium. At that time she complained of marked tenderness in the right lower quadrant. She was not nauseated nor did she vomit and the attack terminated four days later. She was not jaundiced at this time. She has never been entirely free from this pain, however, and on August 31st, 1916, the pain became much more severe. She did not vomit and was not nauseated until September, 1916. The appetite was poor and food, exercise, and riding on street cars increased the pain. There were no symptoms suggestive of urinary disturbance. She was moderately constipated, requiring the use of cathartics twice a week, and stated emphatically that she had never had abdominal distress previous to the attack described.

Physical examination was entirely negative except for the abdomen, where there was

moderate tenderness elicited over McBurney's point and just beneath the costal border in the right mid-clavicular line. There was slight spasm also over McBurney's point.

Clinical diagnosis. Chronic appendicitis; cholecystitis.

Operation. On September 2nd, 1916, following the usual laparotomy preparations, an upper right rectus incision was made. The liver was in its normal position, and on its surface, 1.5 cm. from the edge nearest the gall-bladder, was seen a circular, bluish white cyst

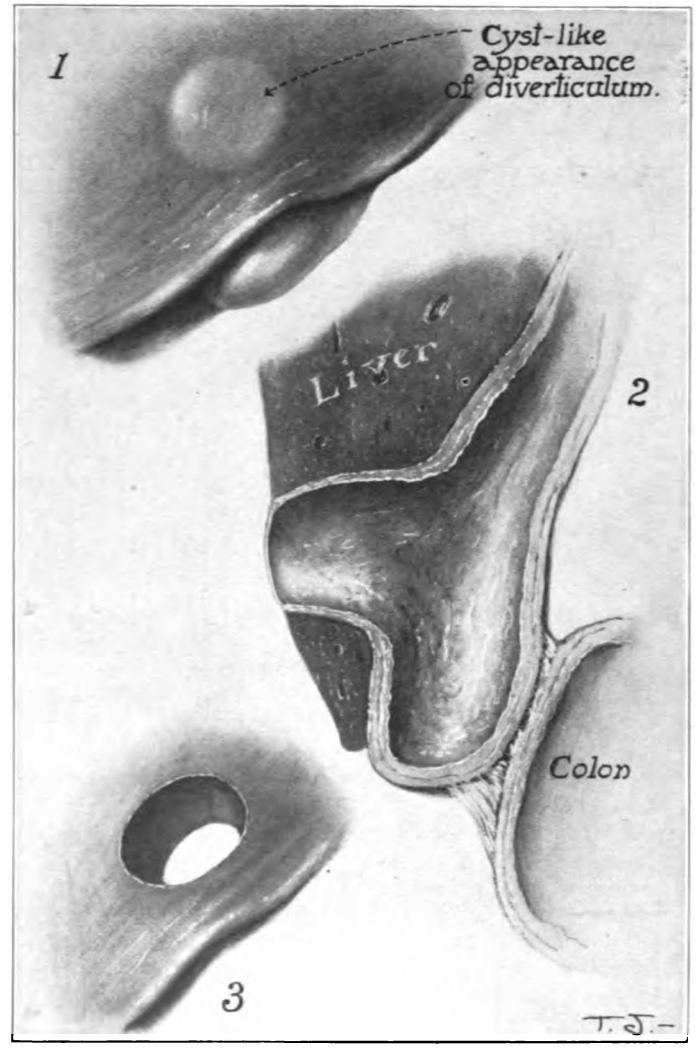


FIG. 1. DIVERTICULUM OF THE GALL-BLADDER (SURFACE VIEW). THE FUNDUS OF THE GALL-BLADDER IS SEEN IN ITS NORMAL RELATION TO THE LIVER.
FIG. 2. CROSS SECTION SHOWING SHAPE OF DIVERTICULUM.
FIG. 3. "PUNCHED-OUT" CYLINDRICAL OPENING IN LIVER AFTER CHOLECYSTECTOMY.

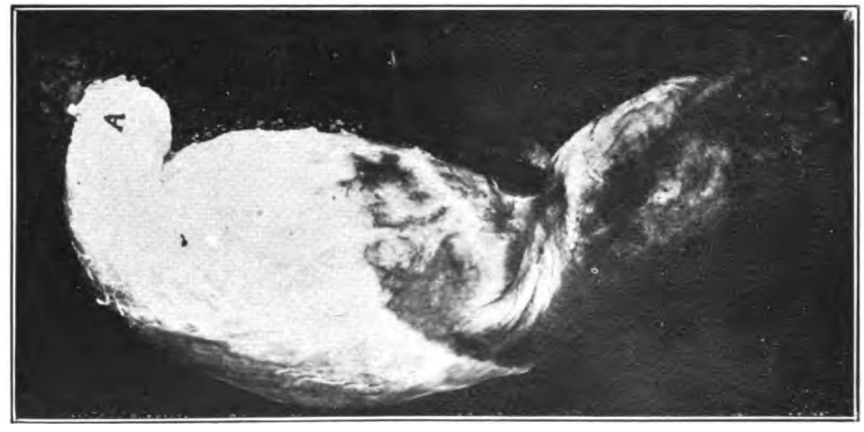
2 cm. in diameter (Fig. 2). This cyst contained fluid and was continuous with a circular opening in the liver. The gall-bladder was found somewhat large and distended and there were found numerous firm adhesions between its fundus and the colon. Adhesions between the duodenum and cystic duct caused a sharp kinking of the duct, which was partially relieved by section of the adhesions.

Because of the marked evidences found of pericholecystitis and of obstruction to the bile-duct, it was deemed advisable to remove the gall-bladder. The cystic duct and cystic vessels were clamped separately, sectioned and ligated. The gall-bladder was stripped

from the liver from below upwards, and it was while doing this procedure that it was noted that the apparent "cyst" in the liver communicated with the gall-bladder, as shown in Fig. 2. The entire gall-bladder, with its diverticulum, was removed, leaving a "punched-out" cylindrical opening in the liver (Fig. 3). The gall-bladder contained yellowish stained mucoid material and the mucosa was reddened, edematous and rugged, suggestive of chronic inflammation. The appendix was found somewhat enlarged at its distal end, and there was a partial constriction 1 cm. from the cecal end. The appendix was removed.

This is undoubtedly a congenital anomaly of the gall-bladder, since no evidences of severe inflammation nor injury were found in this region.

Etiology. It is difficult to ascribe a cause for this condition, since in the study of comparative anatomy there have been found no real perforations of the liver by the gall-bladder. Dévé thinks that the condition is due to the fusion, in embryonic life, of the two lobar surfaces of a deep incisura. In a systematic post-mortem examination of 130 children of all ages, he found a completely perforating gall-bladder in one case and partial perforations in two cases. In eight other instances he found the fundus of the gall-bladder more or less embedded in the liver. He never found the condition in adults, which, he thinks, is due to pressure atrophy of the hepatic bridge from pressure of the abdominal wall and of a distended gall-bladder.



GALL-BLADDER REMOVED IN A CASE OF PERFORATING HERNIA OF THE GALL-BLADDER THROUGH THE LIVER.

OBSTRUCTION OF THE CYSTIC DUCT

Obstruction of the cystic duct causes retention of fluid in the gall bladder with a rapid distension thereof behind the obstruction. This fluid consists of mucus if the infection is slight, or of muco-pus if the infection is more severe. The bile that may be in the gall bladder at the time the obstruction occurs is rapidly absorbed, leaving either the clear mucus or turbid fluid, according to the amount of infection. The distended gall bladder may reach an enormous size and usually becomes palpable. If the inflammatory process be very acute a severe cholecystitis or even gangrene of the gall bladder may result. Associated with this condition a local protective peritonitis usually develops leading to the formation of visceral adhesions.

The early symptoms of impaction of stone in the cystic duct are usually very acute, beginning with a severe colic underneath the right costal arch, and radiating up into the right subscapular region. There is rarely any jaundice accompanying or following the pain. The pain loses its colicky character rather early and there may be only a dull ache or sense of discomfort. If the obstruction becomes chronic and there is little or no infection, a hydrops of the gall bladder develops. If it is associated with infection of any severity, an empyema of the gall bladder is apt to be the result.

All of these symptoms may occur without any evidence of jaundice.

ACUTE CHOLECYSTITIS

The symptoms found in an acute cholecystitis are similar to those present in the early stages of cholelithiasis. In addition to these there is an enlargement of the gall bladder, often making it palpable and very tender upon pressure. There is often acute, severe pain in the gall bladder which may radiate to the back, chest or abdomen. Associated with the pain and tenderness there may be a right-sided rigidity which may simulate appendicitis. The history will help in the diagnosis, as it will be found that the pain was originally in the gall bladder region and later became diffused. As a rule the tenderness, pain and rigidity of the abdomen are limited to an area along the costal margin.

CHRONIC CHOLECYSTITIS

In chronic cholecystitis there is seldom present a definite train of symptoms which would ordinarily direct one's attention to the gall bladder. However, there is usually present a rather constant, dull, aching pain in the right hypochondrium, often hardly noticeable. There may be exacerbations of the inflammatory trouble when the pain will be more marked. The principal symptoms will be in the line of digestive disturbances, manifested by a sensation of fullness in the epigastrium, more or less bloating and distress coming on during or immediately after eating, accompanied by eructations of gas. It is not uncommon for these patients to complain of "sour" stomach.

Occasionally these cases will suffer from a typical attack of biliary colic from the passage of sand-like material through the gall ducts. It is not uncommon in cases of chronic cholecystitis to find the gall bladder filled with black, thick, sandy bile.

The diagnosis depends upon the various gastric disturbances enumerated above, together with the dull aching or burning pain in the right hypochondrium, and the finding of an area of tenderness in the region of the gall bladder. This tenderness is practically always present and can be elicited by placing the finger-tips underneath the costal arch, and when the abdominal muscles are relaxed, have the patient take a deep, full inspiration forcing the gall bladder against the finger-tips.

STONES IN THE COMMON DUCT

History. With stones in the common duct it is not uncommon to find a history of frequent attacks of pain which have occurred at variable intervals for years, accompanied by a slight jaundice. Suddenly there will be an attack of severe pain with a rapid and pronounced jaundice. This is the time at which the stone passes into the common duct. If the stone be a small one it may pass on into the intestine and the jaundice entirely clear up in a few days. If the stone becomes impacted in the common duct there will be a complete obstruction to the passage of bile, resulting in severe jaundice and enlargement of the liver.

It is rare to meet with an acute, permanent occlusion of the common duct from stone. As soon as the stone becomes impacted, the presence of the bile causes a dilatation of the duct so that a stone which at first fits tightly will be loose in the duct, allowing the bile to pass around it. We then have a condition, which Fenger described, of the stone acting as a "ball-valve" in the duct, which then gives a characteristic history of chronic common duct stone: frequent attacks of pain occurring once or twice a week, accompanied by slight rigor and temperature of 101°, with or without noticeable jaundice.

In practically all of these cases close inspection will reveal the presence of slight icterus.

In many patients with an obstruction of the common duct there is a considerable loss in weight. It is important to bear this point in mind, as a symptom of stone in the common duct. The rapid loss of weight is very apt to suggest a diagnosis of malignant disease.

The jaundice of malignant disease is not accompanied by pain, it steadily increases and does not vary from day to day, as it usually does in common duct stones. When the jaundice is due to some pressure from outside the duct, as a carcinoma of the head of the pancreas, the gall bladder will be distended, while in cases where the obstruction is from a stone within the duct the gall bladder is usually contracted.

Indications for operation. So long as the gall stones simply remain in the gall bladder without causing any complications, the harm to the patient is relatively slight. The patient's comfort will be greatly disturbed on account of the disturbances of digestion. The pain will not be extreme and he usually accumulates an abundance of fat, especially in the abdominal walls. It has consequently been held by many authorities that it is not wise to make use of radical measures for the removal of gall stones so long as they do not give rise to any grave disturbances. This undoubtedly would be a proper and reasonable view to take were the danger to the patient approximately the same before and after the occurrence of these complications. This, however, is not the case. Experience has shown us that the mortality in cases which are operated before any serious complications arise is practically nil, while the deaths that happen in the complicated cases undoubtedly might have been saved had the operation been performed before these complications arose.

It was the mortality and complications of delay that placed the early and interval operation for appendicitis on a sound surgical footing. To remove the disease while still in the appendix and avoid the various complications was a logical conclusion. The same reason applies with equal force to the early operation for gall stone disease. Remove the disease while still in the gall bladder.

Complications and sequelæ. The complications which are likely to be caused by the presence of gall stones may be chronic in character, taking the form of digestive disturbances and giving rise to almost constant discomfort. This is probably due to the interference of the passage of food through the pylorus into the duodenum, causing dilatation of the stomach.

Again, the patient may be in a slightly septic condition, because there is more or less absorption of the septic material from the infected residual bile, as well as from the products of fermentation in the dilated stomach. These conditions frequently result in chronic invalidism, making it impossible for the patient to follow ordinary occupations and to enjoy life in any way. The constant irritation of the gall bladder, due to the pressure of the gall stones, undoubtedly has much to do with the development of carcinoma in this organ.

In cases of primary carcinoma of the gall bladder, we have always been able to get a history of gall stones dating back many years, and have invariably found these present in the gall bladder in such instances at the time of the operation or autopsy. Aside from these chronic affections gall stones may at any time cause exceedingly grave acute conditions.

These complications are all the result of inflammation and the sequelæ must consequently depend upon the extent to which this develops.

We take the following list of complications from Mayo Robson's excellent article on this subject, because its arrangement is most satisfactory:

1. Ileus due to paresis of the bowel, leading to enormous distension of

the abdomen and to symptoms and appearances of acute intestinal obstruction, apparently the consequence of the violent pain.

2. Acute intestinal obstruction dependent on
   (a) Paralysis of gut due to local peritonitis in the neighborhood of the gall bladder.
   (b) Volvulus of small intestine.
   (c) Stricture of intestine by adventitious bands, originally produced as a result of gall stones.
   (d) Impaction of a large gall stone in some part of the intestine after ulcerating its way from the bile channels into the bowels.

3. General hemorrhage, the result of long-continued jaundice, dependent either on gall stones alone, or on cholelithiasis associated with malignant disease or with interstitial pancreatitis.

4. Localized peritonitis, producing adhesions which may then become a source of pain even after the gall stones have been gotten rid of. It is believed that nearly every serious attack of biliary colic is accompanied by adhesive peritonitis, as experience shows that adhesions are found practically in all cases where there have been characteristic seizures.

5. Dilatation of stomach depending upon adhesions around the pylorus.

6. Ulceration of the bile passages, establishing a fistula between them and the intestine.

7. Stricture of the cystic or common duct.

8. Abscess of the liver.

9. Localized peritoneal abscess.

10. Abscess in the abdominal wall.

11. Fistula at the umbilicus, or elsewhere on the surface of the abdomen, discharging mucus, muco-pus, or bile.

12. Empyema of the gall bladder.

13. Infective and suppurative cholangitis.

14. Septicemia or pyemia.

15. Phlegmonous cholecystitis.

16. Gangrene of the gall bladder.

17. Perforative peritonitis due to ulceration through or to rupture of the gall bladder or ducts, leading to extravasation of infected bile into the general peritoneal cavity.

18. Pyelitis on the right side due to a gall stone ulcerating or an abscess of the gall bladder bursting into the pelvis of the kidney.

19. Cancer of the gall bladder or ducts.

20. Subphrenic abscess.

21. Pleurisy or empyema of the right pleura.

22. Pneumonia of lower lobe of right lung.

23. Chronic invalidism or inability to perform any of the ordinary business or social duties of life.

24. Gangrenous or suppurative pancreatitis.

25. Chronic interstitial pancreatitis.

26. Infective endocarditis.

27. Cirrhosis of liver.

28. Appendicitis due to extension of inflammation from the gall bladder or to impaction of a gall stone in the appendix.

Contraindications to operation. In disease of the gall bladder there are some definite contraindications to operation which, it is believed, have now been quite thoroughly established by clinical observation.

1. It is ordinarily unwise to operate during the attack of gall stone colic.
2. Severe icterus is a contraindication to a prolonged operation.
3. The same is true of prostration following long-continued suffering.

4. Cases complicated with carcinoma belong to the same class.
5. Patients with ecchymotic spots are almost certain to die if operated.

In all these cases if an operation must be performed it should be limited to drainage of the gall bladder and removal of the stones in this viscus, and all further manipulations should be postponed until the patient is in a better general condition.

Treatment. Gall stones and severe infections of the bile tracts have come to be looked upon as purely surgical affections. However, it has been our experience that cases with acute exacerbations fare better if the operation is deferred until the acute symptoms have subsided. In any case complicated with an acute inflammatory condition, we believe that the same general principle should be employed in the treatment of this condition as inflammatory processes involving the peritoneum from any other cause. So long as there is no circumscribed accumulation of pus, the treatment must consist in rest. This can be secured most readily by using gastric lavage in order to remove remnants of food or decomposing mucus from the stomach, then prohibiting the use of cathartics and of food by mouth.

We desire especially to emphasize the value of securing absolute rest of the stomach by the use of gastric lavage, and then not placing any form of nourishment in the stomach but confining the patient to exclusive rectal alimentation, in the treatment of patients suffering from acute cholecystitis characterized by the presence of severe gall stone colic. We have seen many cases where the pain was excruciating and large doses of morphine given hypodermically failed to give relief, in whom the pain disappeared almost completely without further opiates after the use of gastric lavage. In these cases the pain does not recur unless some form of nourishment is given by mouth; even water often causes recurrence of pain.

It may be difficult to explain this observation, but it is likely that even a small amount of food or mucus in the stomach will be forced into the duodenum and that when it passes over the entrance of the common duct, it causes a contraction of the gall bladder and this excites the pain.

The use of moist heat in the form of poultices or fomentations, or of cold by means of an ice bag, give the patient great comfort and appear undoubtedly beneficial.

Morphia may be given hypodermically if necessary, but so long as neither food nor cathartics are given by mouth the pain usually subsides rapidly and permanently. Nourishment may be supplied by enema not oftener than once in four hours, nor in larger quantities than four ounces at a time. We prefer for this purpose one of the various reliable predigested foods mixed with three ounces of warm normal salt solution. In many cases we give no nourishment solution at all, and instead give continuous salt solution per rectum by the drop method. Unless the acute condition is complicated by a mechanical obstruction of the intestines, the patient's chance for recovery from the acute attack is far better without than with an operation.

It is necessary to make a definite distinction between intestinal obstruction due to peritonitis and that due to a mechanical condition, such as the impaction of a gall stone. The former is so much more common than the latter that it is only very seldom the latter need be considered. Mechanical obstruction due to impaction of a gall stone is characterized by the sudden onset of symptoms of an acute intestinal obstruction, without the inflammatory symptoms which must be present if it was due to a peritonitis.

When the patient has recovered from his acute attack the further treatment may be conducted medically, which will not cure but may improve his condition very greatly, or surgically which is likely to result in a perfect permanent recovery.

Medical treatment. The medical treatment must consist chiefly in the use of large quantities of water, preferably taken hot, and in the use of a diet fairly free from sugar and starch.

We believe, however, that the greatest benefit comes from drinking a great amount of good water and never eating quite enough to satisfy the hunger, and from taking vigorous out-of-door exercise, such as horseback riding, walking or rowing. Sodium phosphate in doses of one drachm or more, in a large goblet of hot water, half an hour before each meal, and pure olive oil in doses of one-half to four ounces, at bed time, seems to have given relief to patients suffering from gall stones, many of them remaining free from severe attacks for a long period of time by combining these remedies with proper diet and exercise.

Whether the relief is due to the fact that in this manner constipation is prevented and elimination facilitated by the large draughts of hot water, or whether there is some special virtue in the remedies, it is difficult to say. That many of the patients are relieved of their gall stone colics upon following this plan of treatment, there can be no doubt.

It is plain, however, that this form of treatment can be of benefit only to a limited number of patients, namely, those in whom there is no impaction of the gall stones in the gall badder, or in the common or cystic duct, and which are not complicated by serious lesions of any portion of the mucous membrane lining these parts, or with extensive adhesions. Moreover, these patients are apt to have recurrences with one or more of the complications enumerated above. Aside from this there is always the danger of the development of carcinoma as a result of the long-continued irritation.

Of late it has been our practice to advise the removal of stones in all cases, provided the patient's general condition would warrant such an operation, and to carry out the palliative measures as described above only in cases that refused operation.

Surgical technique. In operations on the gall bladder and especially those upon the bile ducts, considerable advantage may be gained by placing a sand bag at or under the patient's back at or a little above the level of the liver. This will cause the liver to present in the wound and afford easy access to the cystic and common ducts.

For all gall bladder operations, a straight incision made through the right rectus muscle, near its outer border, is undoubtedly the best, primarily. The upper end of the incision starts at the costal margin and extends downward. The incision is first carried through the skin, superficial and deep fascia down to the muscle fibres.

These should be separated longitudinally, by means of a blunt instrument like the handle of a scalpel, so that none of the fibres shall be cut. The incision is completed by carrying it through the transversalis fascia and the peritoneum. The wound should be long enough to admit the entire hand, as advised by Maurice Richardson. This is important because the next step must consist in a careful palpation of the gall bladder, the cystic, the hepatic and the common ducts. This cannot be done thoroughly without introducing the entire hand.

The pancreas, duodenum and the pylorus should be examined at the same time.

The various incisions used in operations upon the gall tract are illustrated in previous plates.

Should it be found that more room is needed than the rectus incision gives, it may be obtained by carrying the upper end of the incision upwards and inwards, cutting the rectus fibres about one inch from the costal margin, which virtually converts our primary rectus incision into one first suggested by Mayo

Robson. Or this rectus incision may be converted into the "S" shaped incision, as devised by Bevan. It is rare though that there will be need for any other than the straight rectus opening.

CHOLECYSTOTOMY

Cholecystotomy is the operation of choice for removal of stones from the gall bladder.

Cholecystotomy is further performed for the purpose of establishing drainage of the gall bladder, which is useful in not only relieving irritation of the gall bladder and biliary ducts, but indirectly it seems to drain the liver and the pancreas and as a result of this drainage these organs, when generally enlarged as a result of chronic inflammation or irritation due to faulty drainage, will decrease in size very rapidly.

It is consequently important to determine these conditions before deciding upon the operation to be chosen in any given case. After making the incision, the hand is introduced into the abdominal cavity and the gall bladder is palpated between the finger and thumb. It is then followed downwards and inwards and the cystic, hepatic and common ducts are palpated in succession.

Occasionally the gall bladder may be so tense that nothing can be determined concerning the character of its contents, except that whatever the gall bladder may contain it is impossible for this substance to pass on freely into the duodenum, and this, in itself, is the strongest indication for a cholecystotomy. If this condition is found, or if gall stones are discovered in the gall bladder or the cystic duct, but none in the hepatic or common ducts. this operation is plainly indicated.

The examination may have revealed more or less extensive recent or old adhesions between the gall bladder and the surrounding organs.

These adhesions may include the liver, the omentum, the transverse colon, the duodenum, or the stomach and in some instances even the right kidney, or they may include any two or more of these organs.

If they are recent, or if they distort one or more of these organs, it is well to loosen or ligate and cut these adhesions. If they have existed for a long period of time without apparently doing any harm, it is better to leave them undisturbed. It must, however, be borne in mind that undoubtedly the adhesions of the gall bladder frequently draw this down and cause it to become sacculated so that it will contain residual bile, which in turn favors infection of this fluid, and thus the formation of gall stones. It is consequently important to remove any adhesions which seem to show a tendency to cause sacculation of the gall bladder.

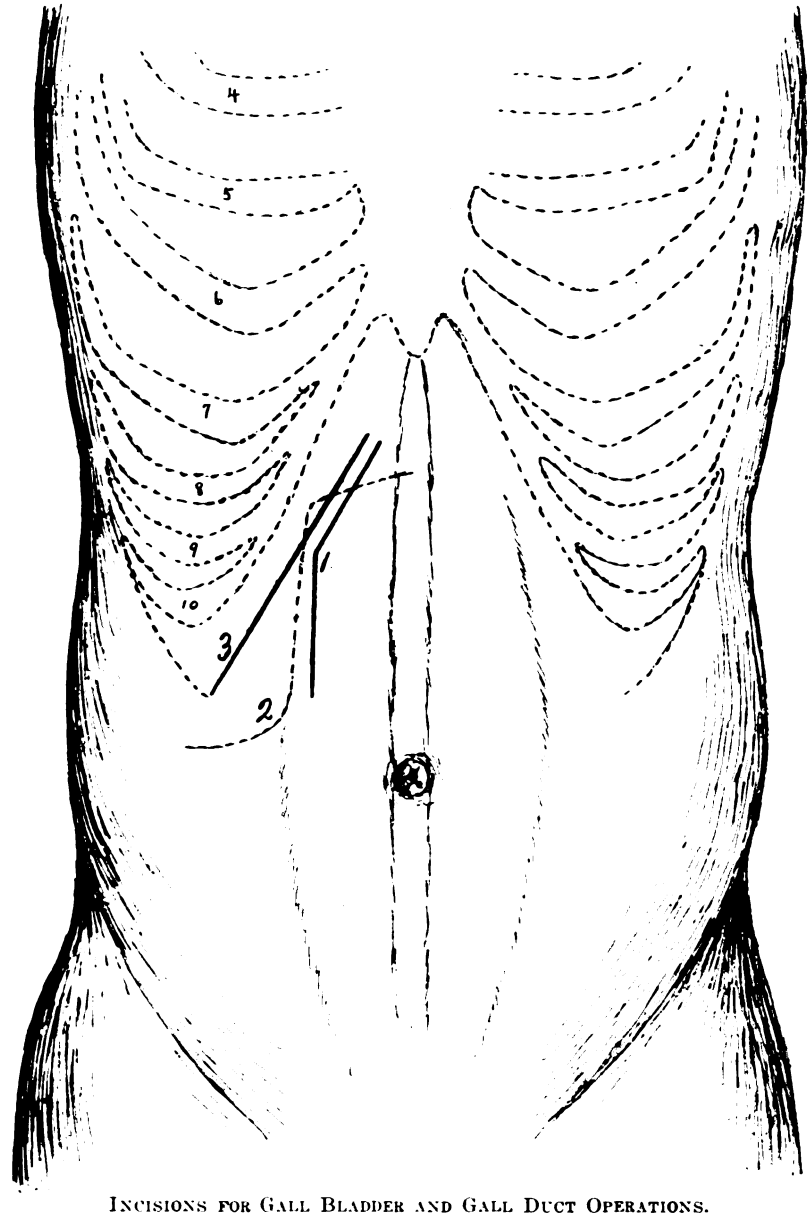
This having been accomplished, soft gauze pads moistened with warm normal salt solution are placed about the gall bladder after the latter has been grasped at its most prominent point with one or two pairs of forceps.

This act of packing away the remaining portion of the peritoneal cavity should be done with the greatest care, to prevent soiling during the following steps of the operation.

A trocar is then plunged into the gall bladder to drain away the bile, pus or mucus, as the case may be, contained in the cavity. The trocar devised by Dr. E. H. Ochsner is undoubtedly most convenient, because with it the gall bladder can be emptied perfectly without the slightest damage or soiling any of the surrounding tissues.

Should the gall bladder be contracted because of the long-continued destructive inflammation, which distinguishes old gall stone cases from obstruction due to malignant growths, according to the law of Courvoiser, it might not be necessary to make use of the trocar, because there will be no bile in

what is left of the gall bladder. In these cases the most prominent portion of the gall bladder is grasped by the forceps and an incision made through the



INCISIONS FOR GALL BLADDER AND GALL DUCT OPERATIONS.

1. Right rectus incision with extension at upper end, according to plan of Mayo Robson.
2. Right rectus incision with upper and lower extension, according to plan of Bevan.
3. Oblique incision along border of ribs.

highest part, which is also the next step after the fluid has been aspirated in the other class of cases.

If there is still a little fluid present, this is absorbed by lightly tamponing

the cavity of the gall bladder with a narrow strip of aseptic gauze and withdrawing it. This can be repeated a number of times. A blunt gall stone scoop is now introduced and gently withdrawn, bringing out as many of the stones as can be reached in this manner. Then, while the assistant holds up the gall bladder with hemostatic forceps attached to the edge of the wound, the surgeon's hand is again introduced into the abdominal cavity, and the gall bladder and all its ducts are once more carefully palpated.

If stones are still present, these can be removed with the scoop, guided by the hand in the abdominal cavity. If there are stones in the cystic duct, these can frequently be forced back into the gall bladder by a gentle "milking" motion between the forefinger and thumb. Occasionally this can be aided by the use of a small curette guided by the other hand.

In a few instances it has been possible to transfer to the gall bladder not only stones in the cystic duct but even those in the common and hepatic duct. Great caution must, however, be practised, because less injury is done to the patient by making an incision into these ducts than by severe manipulation in the attempt at removing stones, especially if these are immovable as the result of impaction.

So far, the steps of the operation are agreed upon practically by every one who has had a large experience in the treatment of these cases. But from this point on, authorities of equal ability vary in details of their technique.

Varying methods. We have used, at various times, most of the methods that have been recommended, thinking one might be indicated under certain conditions, while another might be more suitable for a slightly different case, but we are convinced that the special benefits from these various operations are entirely imaginary, and that this is simply a remnant of the pedantry which has been so uniformly a part of our professional work for centuries.

A proven simple technique. In over two thousand successive cases we have employed the following simple technique, after being satisfied that all the stones had been removed.

1. The gall bladder is carefully, but gently and loosely, tamponed with a long strip of dry gauze. This serves to prevent hemorrhage from the mucous lining of the gall bladder, which is frequently severely congested and often covered with bleeding granulations.

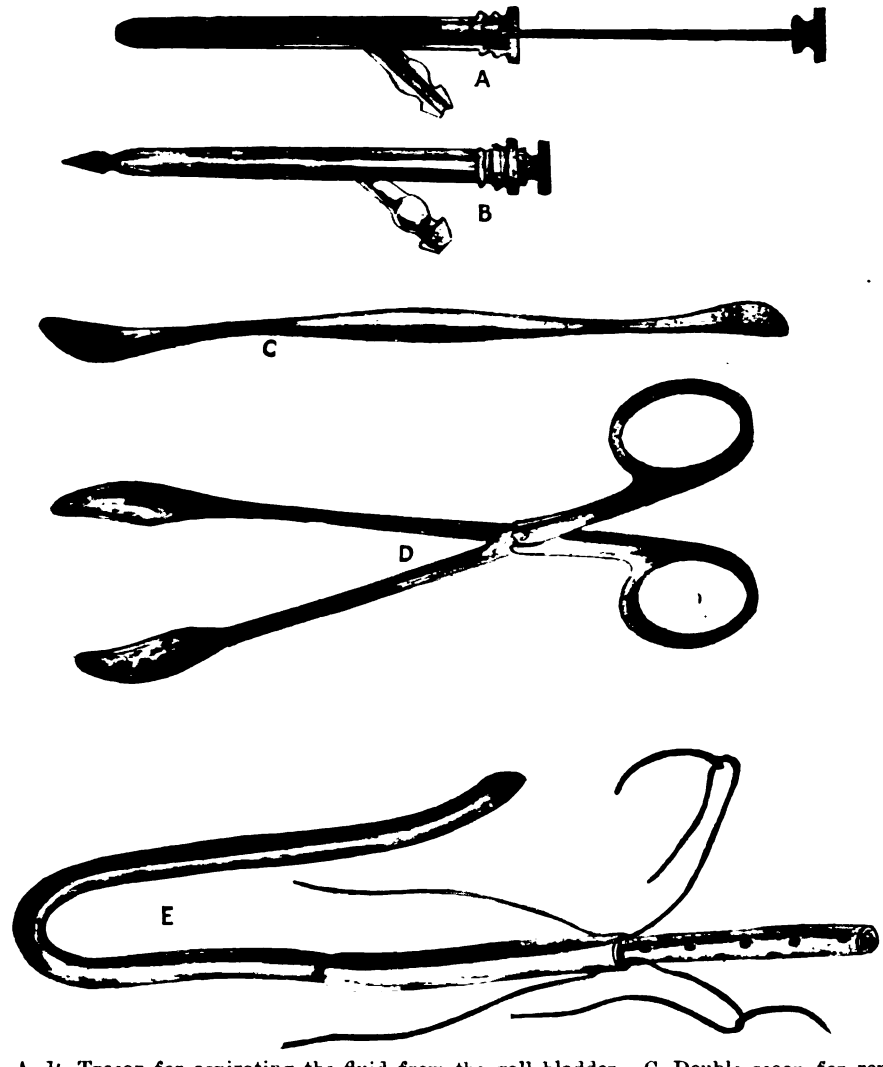
2. The transversalis fascia and the peritoneum of the upper angle of the wound is then sutured to the edge of the gall bladder, one to two cm. back from the edge of the opening. The accompanying plate shows the gall bladder with the forceps upon its edge and drawn out through the wound, and a catgut stitch being placed which attaches the gall bladder to the peritoneum. The stitch in the gall bladder passes down to, but not through, the mucous lining of the gall bladder.

If the gall bladder is small and shrunken the peritoneum and transversalis are brought down to it at one or two points and a piece of gauze is carried down to the gall bladder, and between the gauze and the surrounding tissue a piece of rubber tissue is placed. Attaching the gall bladder in this manner facilitates drainage, and prevents the gall bladder, later on, from becoming sacculated.

3. The abdominal wall is now closed as illustrated in the plate. Two of the fine silk-worm gut stitches are passed through all the tissues down to, but not through, the transversalis fascia; these are left untied until the following rows of catgut sutures have been applied in order to prevent the formation of a ventral hernia, by carefully approximating the following lay-

ers; a, peritoneum and transversalis fascia; b, rectus abdominis muscle, aponeurosis of the external and the outer layer of the internal oblique muscle passing in front of the rectus abdominis muscle at this point; d, the skin.

These layers are all approximated by suturing with unchromicized cat-gut,

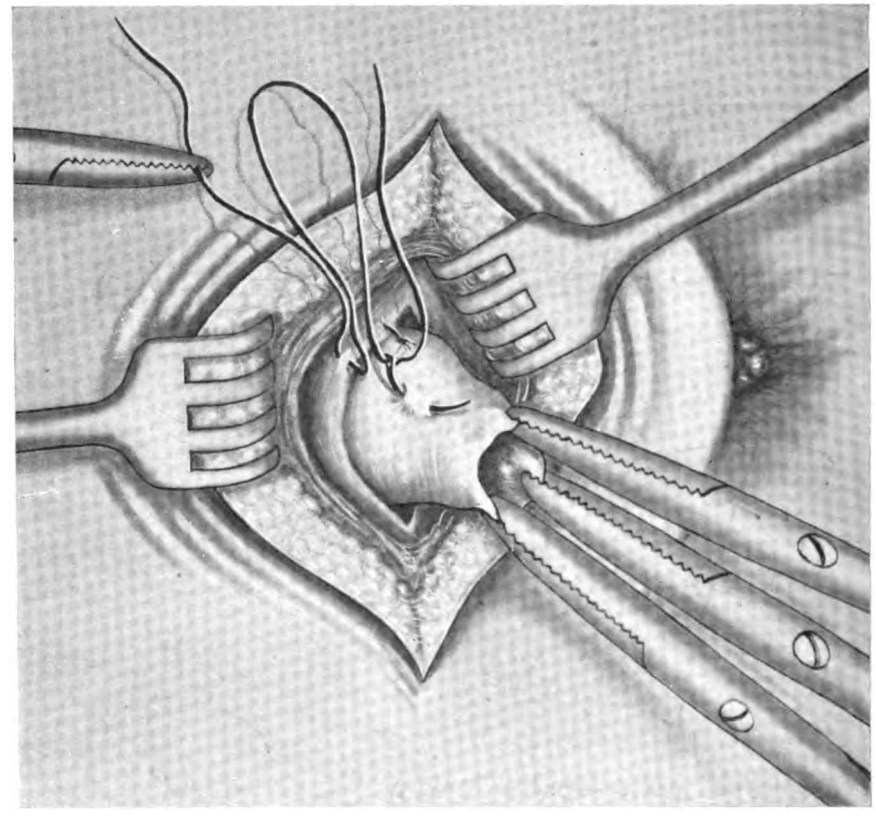


A, B, Trocar for aspirating the fluid from the gall bladder. C, Double scoop for removing gall stones. D, Forceps for removing gall stones. E, Rubber tube used for the hepatic or the common duct.

except the skin, for which horse-hair is used. Now by tying the silk-worm gut sutures the closure of the wound is completed.

4. Some rubber tissue is now stuffed down to the gall bladder, between the edges of the abdominal wall and the gauze tampon, to facilitate the removal, about the fifth day, when the rubber drainage tube is inserted in the gall bladder in its place.

Other methods. The other methods which seem equally satisfactory consist in substituting for the gauze tampon in the gall bladder, a simple rubber tube, or a split rubber tube filled with a strip of gauze or a cigarette drain. Any one of these may be fastened in the gall bladder by placing a purse-string suture around the opening, inverting the edges, and then drawing the purse-string just sufficiently tight to prevent leakage.



CHOLECYSTOTOMY.

The wound is held open by means of sharp retractors. The gall bladder is drawn out of the abdominal wound by means of hemostatic forceps; one suture is in place attaching the gall bladder to the peritoneum and transversalis fascia, and a second suture is being applied. The umbilicus should be opposite the lower end of the incision, instead of being opposite its center.

This incision should be three inches nearer the costal arch. It is well to insert the suture on the side of the gall bladder transversely in order to grasp and compress the branches of the cystic artery more perfectly. Omitting this precaution may occasionally result in severe hemorrhage.

Still another method consists in applying one of these various forms of drainage, and then simply permitting this to project from the upper angle of the abdominal wound without suturing the gall bladder to the parietal peritoneum. Personally, we have never been favorably impressed by this course.

In case it seems wise to continue the drainage of the gall bladder for a considerable period, the patient can be made more comfortable by inserting a Jacob's retention catheter of proper size into the gall bladder, placing a

glass tube in the distal end of this catheter and tying a soft rubber bag to this in order to collect the bile. (See plate.) Whenever it seems the proper time to interrupt this drainage, the opening will close spontaneously upon withdrawing the catheter.

For a time we substituted a rubber drainage tube for the gauze packing in these cases, but this was followed in a large proportion of cases by unsatisfactory results. It seemed that while the gauze packing had caused the more or less pathological mucous membrane lining of the gall bladder to change to a normal condition, the presence of a rubber drainage tube seemed to increase the pathological condition of the mucous lining and we found it necessary to remove quite a proportion of the gall bladders which had been drained by means of a drainage tube. We also found that in inserting the drainage tube into the gall bladder after removing the gauze packing about the fifth day, a similar effect resulted in some cases, and that the late results in those cases in which no further attempt was made for drainage except by the use of a Jacob's catheter, were very much more satisfactory.

We also found that gall bladders that were not sutured to the peritoneum and transversalis fascia were more likely to give trouble following the operation than those in which this step was made use of in the operation.

CHOLECYSTECTOMY

This operation seems indicated in cases in which there is a permanent obstruction of the cystic duct, which is usually due to a cicatricial contraction of an ulcer, most commonly caused by the impaction of a stone.

It may also be due to the formation of a valve in the neck of the gall bladder at its entrance into the cystic duct. Occasionally such a valve will permit the free flow of bile into the gall bladder, but will not in the opposite direction. The gall bladder should also be removed in cases in which its walls are so thin that it will not be able to act as a contractile organ.

Cholecystectomy should be performed in early cases of primary carcinoma of the gall bladder. In all cases in which the gall bladder has been badly diseased for some time, the disease being limited to the organ alone, and circumstances permit of easy removal, cholecystectomy will be the operation of choice.

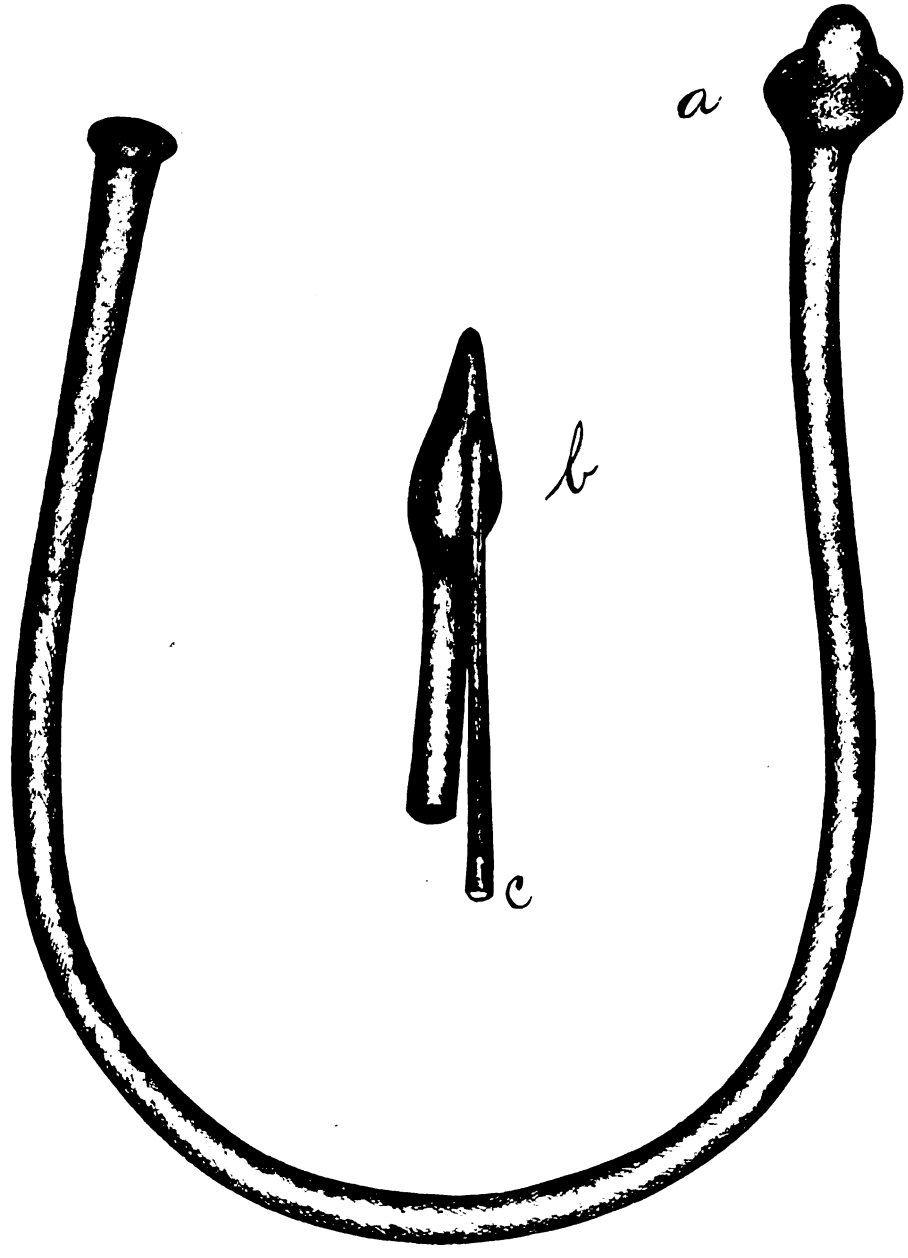
The removal of the gall bladder is usually not a difficult matter if it is approached from the right direction. The following simple steps should be followed:

1. The same incision as in cholecystotomy should be made. Occasionally if there are many adhesions, so that it is difficult to reach the lower end of the gall bladder, the incision may be lengthened, according to the plan advised by Bevan, by extending the upper end of the incision inward and the lower end outward; or it may be extended according to Mayo Robson, between the edge of the costal cartilages and the lower end of the sternum, in order that the liver with the gall bladder may be inverted in an upward direction.

2. Two pair of hemostatic forceps are then applied, one directly to the cystic duct, grasping at the same time the cystic artery which supplies the gall bladder; the second pair is applied to the neck of the gall bladder at a distance of one cm. from the other. The plate shows the two pair of forceps in place. The gall bladder is now cut loose just beyond the second forceps and between this and the first pair, as shown in the next plate.

3. An incision is now made along the sides of the gall bladder, through its peritoneal covering, about one cm. from its attachment to the liver, and then the organ can be enucleated without difficulty.

If there is any considerable amount of hemorrhage from the surface, a

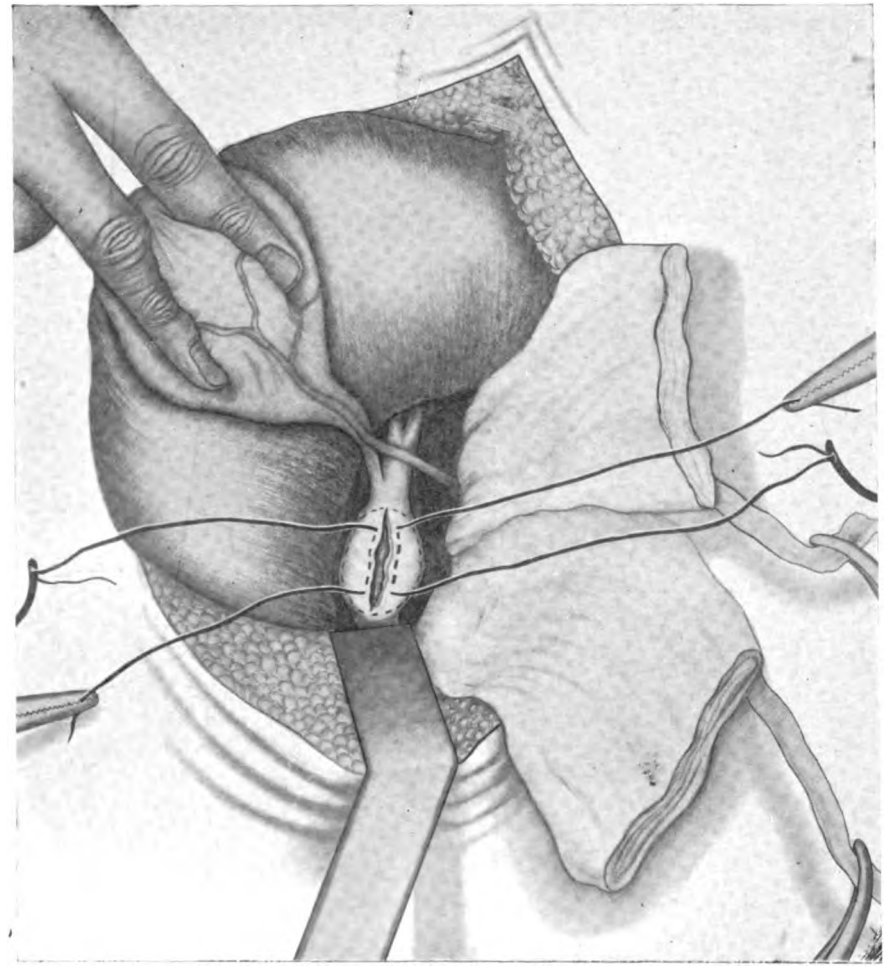


RETENTION TUBE, AFTER THE PLAN OF JACOB'S RETENTION CATHETER.

a shows the bulb-like end in the position it takes when in place. *b* shows the end stretched over a probe *c* in order to reduce its size during its introduction. To be used in draining cavities like the urinary bladder, gall bladder, hydronephrotic kidney, etc. This tube is also used as a permanent feeding tube in gastrostomy.

hot tampon of gauze against the surface for a few minutes will control the oozing at once, and then the raw surface can be closed by suturing the two peritoneal folds with catgut as shown in the plate.

The next plate (a) shows the cutting of the peritoneal fold between the gall bladder and the liver; (b) where the gall bladder and the cystic duct have



REMOVAL OF STONE FROM COMMON DUCT AND DRAINAGE OF COMMON DUCT.

Sutures of fine cat-gut are applied to each side of the proposed incision. These are utilized later to hold in place a rubber drainage tube which is inserted in the incision in the common duct, and also for fastening a piece of gauze which is packed around the tube to further protect the general peritoneal cavity against contamination.

(Taken from Dr. W. J. Mayo's original drawings.)

been removed. Then following (a) where the two edges of the peritoneum have been sutured covering over the raw surface made by excising the gall bladder; and (b) shows rubber drain placed in hepatic duct which is pulled downwards for sake of illustration.

4. Disposition of the stump. If drainage is not desired, a ligature can be placed about the stump of the cystic duct. including the cystic artery.

If it is doubtful, the artery forceps may be left in place, and may be surrounded by gauze and rubber protective, and permitted to pass out of the upper angle of the wound. This may be loosened after thirty-six hours, or sooner, if it should become apparent that drainage is desired.

It is well in these cases to insert a drainage tube to a point just below the stump for the purpose of providing for an emergency. It is immaterial what form of drainage tube is chosen. In case drainage of the cystic duct is desired, the cystic artery is caught separately at the end of the stump and ligated and a small rubber drainage tube is introduced directly into the common duct through the cystic duct.

The figure (e) shows a drainage tube which is most useful in these cases. A small rubber drainage tube is drawn through a larger tube, the perforated end is introduced into the cystic duct, and it is held in place by one or more catgut sutures, which pass through the outer tube but do not touch the inner tube. By the time the catgut is absorbed, it is time to withdraw the drainage tube.

The abdominal wound is closed as in the previous operation, and the tissues are prevented from adhering to the gauze by the interposition of rubber tissue.

During the past few years the operation of cholecystectomy has been done very much more frequently than in former years, chiefly because of the fact that the results following cholecystotomy have been unsatisfactory in the hands of many surgeons. In our experience this has been the case almost exclusively in cases in which we made use of the rubber drainage tube for the gall-bladder, instead of packing it with gauze. We have, however, always removed the gall-bladder in cases in which this organ seemed to have been severely damaged by disease, or in cases in which the cystic duct had been damaged.

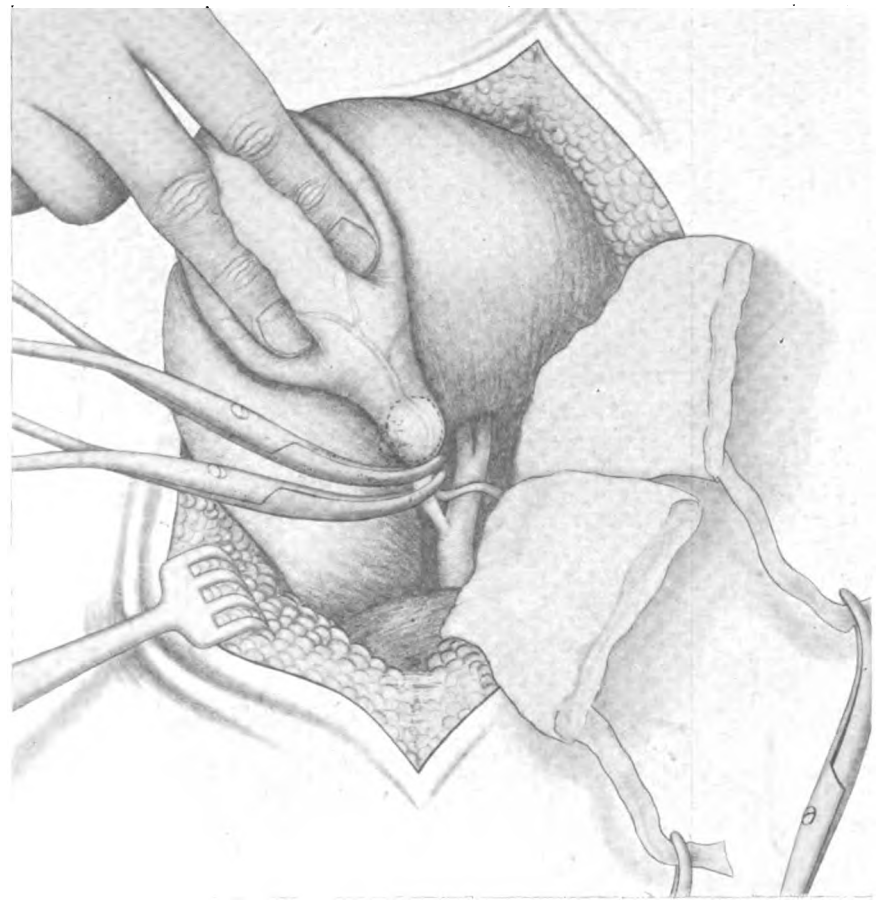
Since the introduction of almost universal cholecystectomy, scarcely a week passes but that we see in our clinic cases which have had their gall-bladders removed and who seem to be in a very much worse condition than they were before they had been operated upon, according to their story. It is quite likely, however, that these cases greatly exaggerate their symptoms, but our experience in this direction has caused us to doubt the efficiency of cholecystectomy, except in cases in which the above indications are present.

Occasionally it is not possible to determine with certainty the point at which the common duct and the cystic duct and the hepatic duct join. In these cases it is difficult to determine the correct point at which the forceps (shown on the following page) should be applied. If they are applied proximally to the proper position, a portion of the neck of the gall-bladder will remain and may give rise to further trouble. If they are placed too far down, the hepatic duct is likely to be injured. In these cases it is better to empty the gall-bladder, as described in connection with the operation of cholecystostomy, and to pack the gall-bladder with gauze and then proceed to remove the organ from its distal portion toward the cystic duct, which can readily be recognized when it is reached. For this purpose the peritoneum should be cut half a cm. from the edge of the liver down to the mucous membrane of the gall-bladder, and this should be enucleated. Any small bleeding points can be caught as they are encountered. If the cystic duct has been exposed, it can be treated as described in the previous operation.

CHOLEDOCHOTOMY

In operation upon the common duct a sand bag is always placed under the back opposite the liver, as advised by Mayo Robson. The usual straight incision is made through the right rectus muscle. If it is found necessary to

open the common duct and more room is desired, the incision is carried upward and inwards between the right costal margin and the ensiform cartilage. Now by lifting the lower edge of the liver out of the wound, it will be found that the gall bladder and the cystic and common ducts will be brought into plain view. The liver is held in this position by an assistant who grasps its lower



EXCISION OF THE GALL BLADDER.

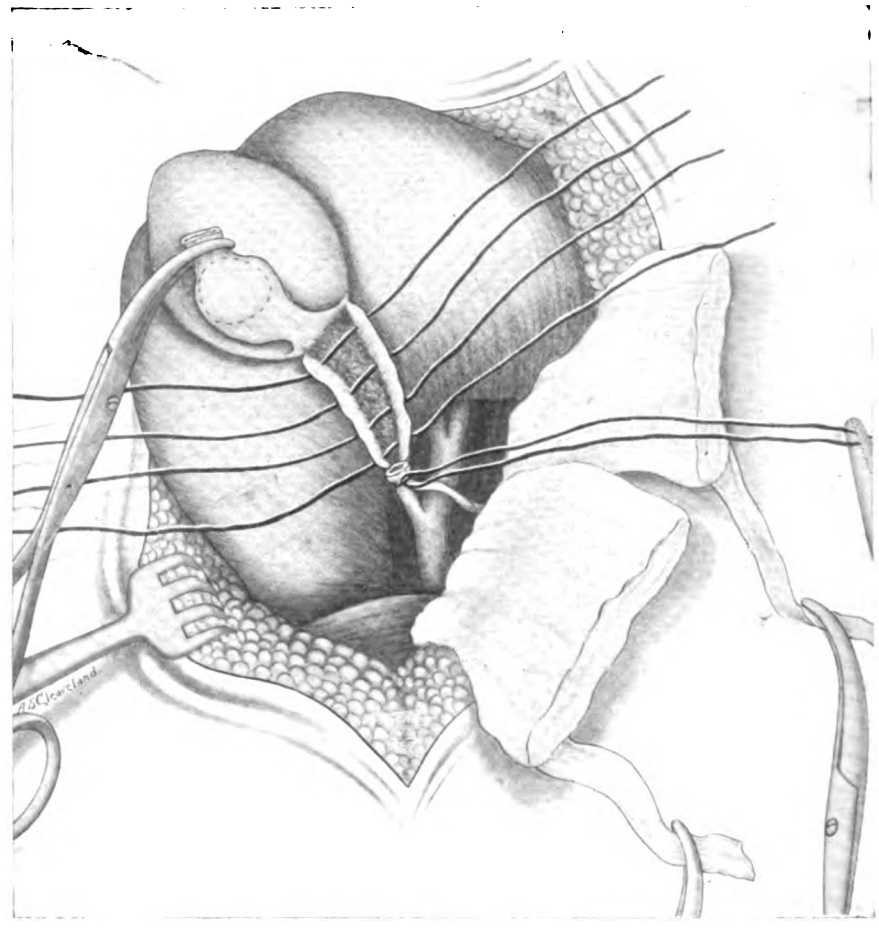
Two pairs of forceps are in place, one grasping the neck of the gall bladder at its entrance into the cystic duct, the other grasping the cystic duct just below this point. Both forceps also grasp the cystic artery. A dotted line indicates the position of a stone in the neck of the gall bladder wedged in and obstructing the latter. The gall bladder is to be removed from below upward, the forceps applied to the neck of the gall bladder, including the cystic artery, making the operation almost bloodless.

(Taken from Dr. W. J. Mayo's original drawings.)

edge with his fingers covered with a piece of dry gauze. When the liver is held in this position it will be found that the cystic and common ducts make an almost straight passage from the neck of the gall bladder to the entrance into the duodenum.

If there are adhesions about the ducts these are separated and a spoon is placed in the kidney pouch and the entire field of operation protected by sterile pads.

The stone is located and grasped between the thumb and finger of the left hand. While the stone is held in this position, two catgut sutures are placed into the side of the common duct directly over the stone. These sutures are left long. A little tension is made upon the sutures, then the duct is opened by making a longitudinal incision between the two sutures directly over the stone.



EXCISION OF THE GALL BLADDER BEGINNING FROM BELOW.

A ligature has been placed around the cystic duct. The neck of the gall bladder just above the cystic duct is grasped by forceps to prevent leakage. A dotted line indicates the position of a stone wedged into the neck of the gall bladder and causing complete obstruction. The cystic duct and the common duct are also shown. Sutures are in place to close the space formed by the loosening of the gall bladder.

(Taken from Dr. W. J. Mayo's original drawings.)

One of the accompanying plates illustrates a stone in the common duct, and two catgut sutures applied to each side of the proposed incision and the incision made directly over the stone.

After all obvious stones have been removed, the finger should be passed into the duct to detect any stones that might be above or below the incision.

Any sand or thick bile is removed by packing strips of gauze into the duct in the manner described in sponging out the gall bladder. When the duct is

clear, the incision in it may be closed by suture or may be drained. If there is not much evidence of infection of the common duct, and the gall bladder looks healthy and the cystic duct is patent, the wound in the common duct can be closed with safety, leaving drainage of the bile through the gall bladder only. The incision in the duct is closed by first approximating the edges with a fine, continuous catgut stitch, and over this a few Lembert stitches of silk. A cigarette drain is placed down to the common duct and brought up out of the incision by the side of the gall bladder drain.

The majority of the cases require drainage of the common duct, especially in those where the head of the pancreas is enlarged from chronic pancreatitis.

A double drainage tube as shown in figure (e), is inserted into the common duct and carried upwards towards the hepatic duct. The two catgut sutures which were placed in the sides of the duct are now utilized to fasten the drainage tube in place, which is done by passing the sutures through the outer rubber tube and tying. These sutures are still left long.

Now a piece of iodoform gauze is packed around the tube and brought up out of the wound by the side of the drainage tube to further protect the peritoneal cavity. These same sutures are now passed through the gauze and tied so that there can be no displacement of the gauze should the patient vomit after the operation.

The operation is completed by closing the wound in the usual manner.

CHOLECYSTENTEROSTOMY

This operation is indicated in cases in which there is a permanent obstruction between the entrance of the hepatic duct into the common duct and the opening of the later into the duodenum, also in cases of chronic interstitial pancreatitis.

The entire alimentary canal should be thoroughly emptied before the operation is undertaken, by the administration of two large doses of castor oil, twelve to twenty-four hours apart, then a careful anastomosis from one-half to one inch in length should be made by any one of the various methods employed in making intestinal anastomosis with needle and thread.

If a mechanical device is employed, the small Murphy button should be chosen, but the suture seems to be a superior method.

After-treatment. When the operation is completed a dry, sterile, gauze dressing is applied and held in place by an abdominal bandage applied tightly, so that if vomiting should occur, the wound will receive some support from the bandage.

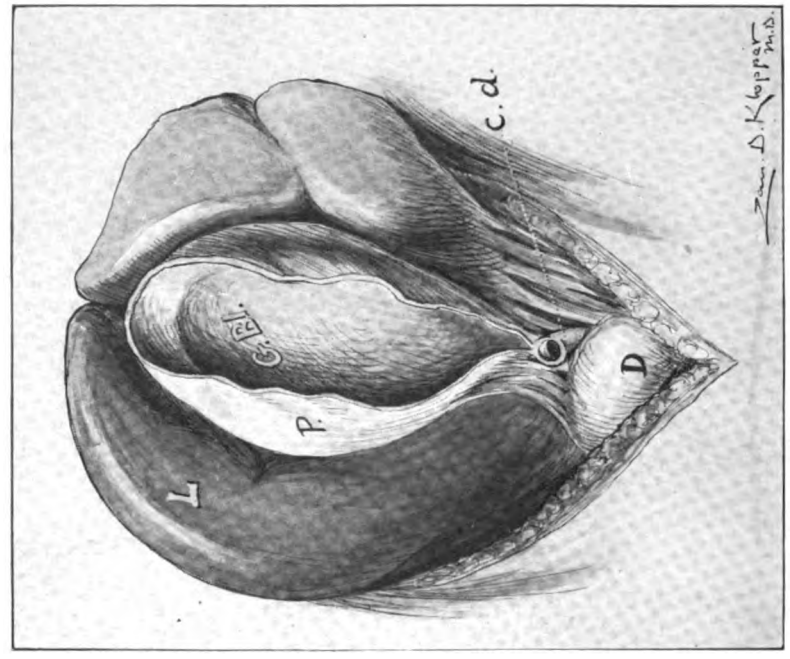
No water is allowed by mouth until the ether sickness and the nausea are over. If the thirst is great the mouth may be flushed frequently with water and an enema of a pint of salt solution may be given.

If the pain is severe, morphia in doses of $\frac{1}{8}$ to $\frac{1}{4}$ of a grain may be given hypodermically.

Four to eight ounces of normal salt solution are given as an enema every four hours for the first twenty-four hours. Then nourishing enemata in the form of liquid peptonoids, one ounce, with normal salt solution four ounces, are administered every four hours, for two or three days.

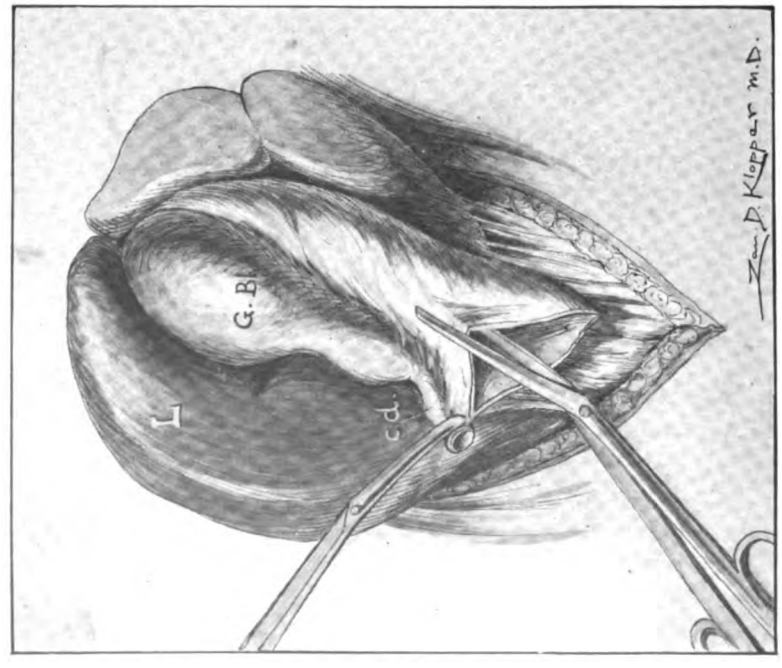
As soon as the sickness from the anesthetic is over, small quantities of water may be given by mouth, and on the third or fourth day beef-tea or broth may be allowed, increasing the diet slowly from this time on.

The wound is dressed daily with dry, sterile gauze, and on the fourth day the gauze is removed from the gall bladder and a rubber tube substituted, which in ordinary cases is removed at the end of a week or ten days, and the wound allowed to close.



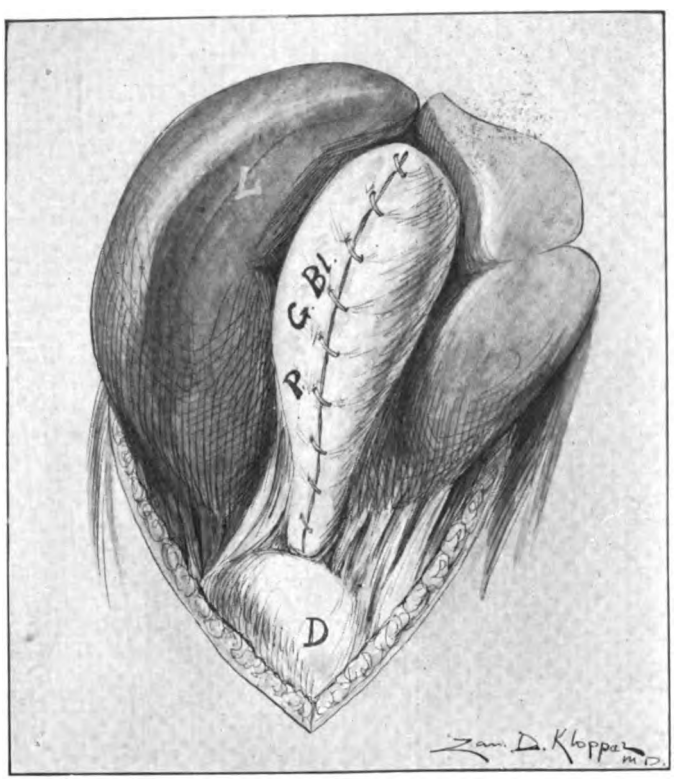
b.

(b) Shows where gall bladder and cystic duct have been removed.



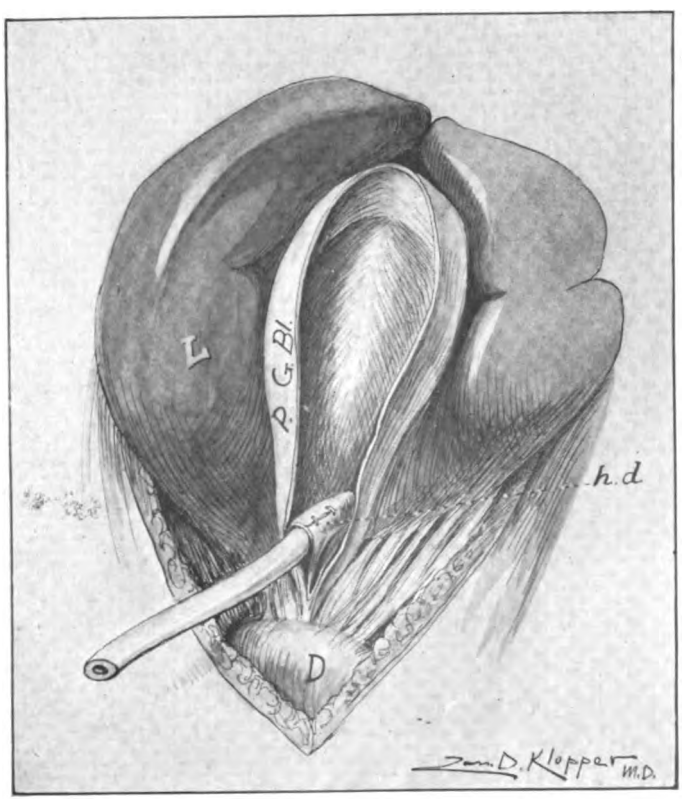
a.

(a) Shows the cutting of the peritoneal fold between gall bladder and liver in operation of cholecystectomy.



a.

(a) Shows where the two edges of the peritoneum have been sutured, covering over the space from which the gall bladder has been removed.



b.

(b) Shows rubber drainage tube in hepatic duct after the gall bladder has been excised. The hepatic duct is pulled downwards for sake of illustration.

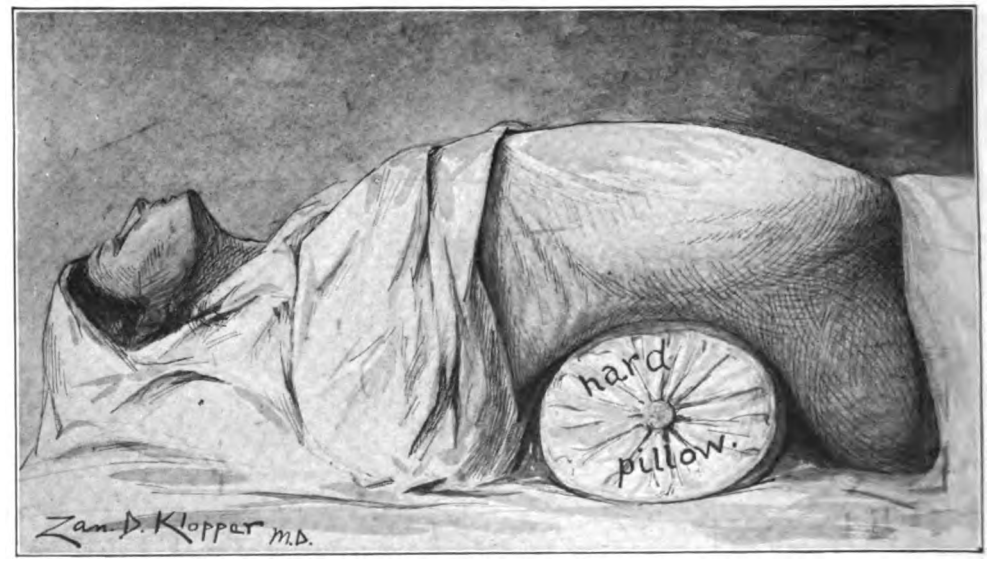
In cases accompanied by pancreatitis or a marked cholangitis, the drainage is continued for a period of from two to four weeks.

The stitches are removed on the twelfth day and the patient allowed to get up at the end of fourteen to eighteen days.

CONSTRICTION OF THE DUODENUM BELOW THE ENTRANCE OF THE COMMON DUCT

Several years ago our attention was first directed to an interesting condition which is frequently present in patients who come under observation during gall-bladder and stomach operations.

In many of these cases the duodenum is distended with gas to a point just below the entrance of the common duct, while below this it is contracted. and upon raising the transverse colon and finding the origin of the jejunum,



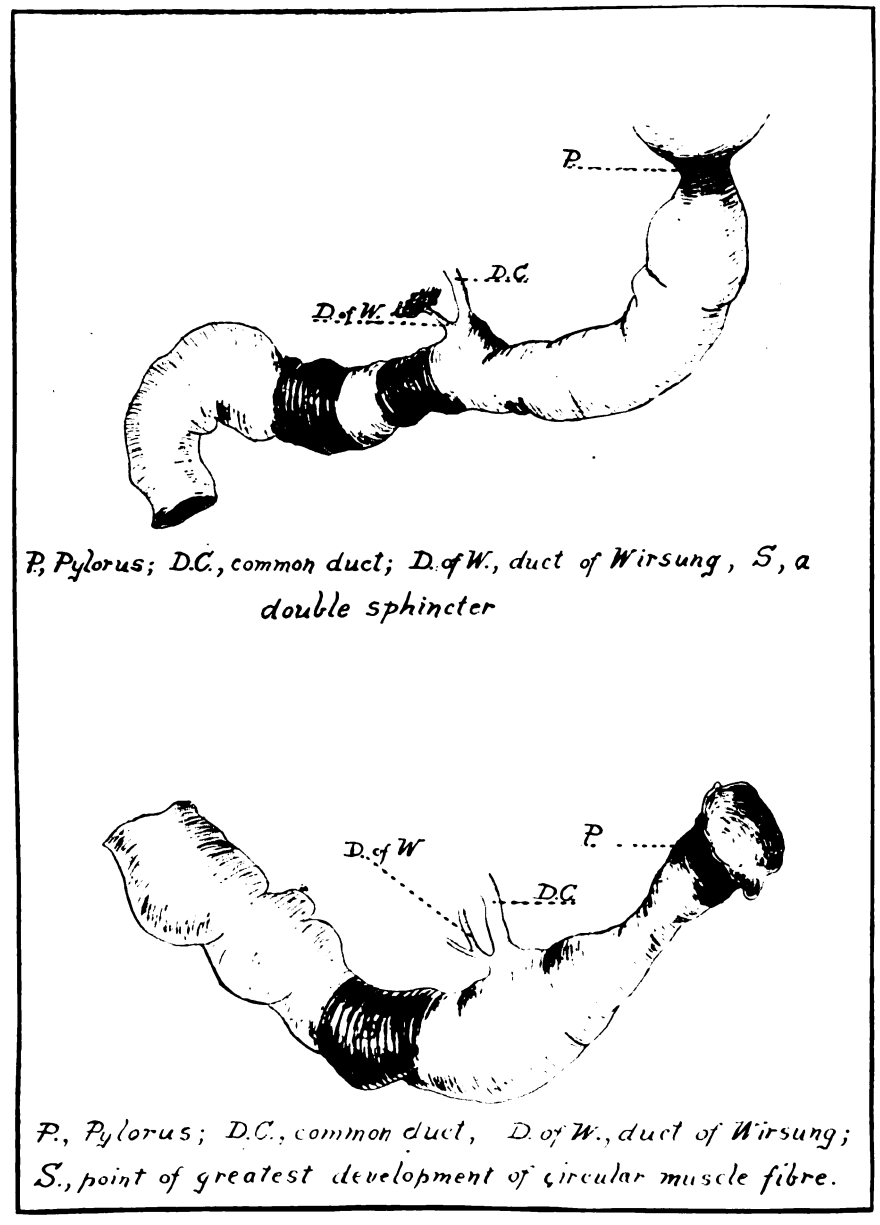
ILLUSTRATING MAYO ROBSON'S POSITION OF THE PATIENT DURING OPERATION UPON THE COMMON DUCT.

this portion of the intestine will also be found contracted. In looking over authorities upon the subject of anatomy, we found they all state that the third portion of the duodenum is the narrowest part of this intestine if they make any statement upon the subject. They also state that the first portion of the duodenum is usually found stained with bile after death. Several further clinical observations pointed in the same direction. It was found that the dilatation of the upper portion of the duodenum was most commonly present in patients suffering from chronic cholecystitis with sand or gall stones in the gall-bladder. In these cases there was frequently a more or less marked enlargement of the pancreas.

In having the vomitus examined systematically for a considerable period of time in patients who had been subjected to general anesthesia for operation, it was found that it invariably contained bile, showing that there must be some reason why this fluid should be forced upward past the pyloric sphincter rather than downward through the small intestine.

Again, it was found that in patients suffering from acute gall-stone colic,

the spasmodic pain would subside invariably within a few hours upon making careful gastric lavage and prohibiting the introduction of any kind of food


P.
D.C.
D. of W.
P, Pylorus; D.C., common duct; D. of W., duct of Wirsung, S, a double sphincter
D. of W
P.
D.C.
P., Pylorus; D.C., common duct, D. of W., duct of Wirsung; S., point of greatest development of circular muscle fibre.

SHOWS DRAWINGS OF TWO SPECIMENS REMOVED FROM THE CADAVER, SHOWING THE LOCATION OF THE CIRCULAR MUSCLE FIBERS OF THE DUODENUM.

into the stomach, although without this aid large doses of morphine, given hypodermically, had produced at best only temporary relief.

This seemed to indicate that there must be some point near the entrance of the common duct into the duodenum which regulates the passage of food through this intestine.

These clinical observations induced us to make a careful anatomical study of this portion of the small intestine, both in the living patient and in the cadaver.

An assistant, Dr. E. W. Thuerer, made a careful examination of the duodenum in thirty-nine cadavers, which revealed in every specimen an anatomical condition of the duodenum consisting in a marked thickening of the circular muscle fibres of this portion of the alimentary canal at a point below the entrance of the common duct. The accompanying illustration shows a drawing of two typical specimens removed.

A considerable variation was found in the exact position of these muscle fibres. In some instances they were arranged in a narrow circular band forming a distinct sphincter; in others the thickening was diffused, making a broad, circular band; and in a few instances the thickening was in two different bands, with an intervening portion in which the circular muscle fibres were of the same thickness as the remaining portion of the duodenum.

There was a further difference in the location of this duodenal sphincter; in most specimens it was located from 3 to 10 cm. below the point of entrance of the common duct, while in a few instances a portion of the sphincter included a point of entrance of the common duct, the remaining portion, however, being always located below this point.

These conditions seem to explain a number of physiological facts; that vomiting when the stomach is relatively empty always expels a certain amount of bile; and that in many cases in which there is a dilatation of the stomach without constriction of the pylorus, with an ulcer in the pyloric end, the ulcer frequently extends into the duodenum. It may also explain some of the stomach symptoms which are so constantly observed in connection with gall stone disease. It will also explain a condition not infrequently encountered in operating for the relief of gall stones and ulcer of the stomach, that is, the presence of a greatly distended duodenum, with a completely contracted first portion of the jejunum.

It also explains the presence of the bile-staining of the portion of the duodenum above the common duct in the cadaver, while the portion below this point is usually free. This has been noted by many observers.

It has seemed as though this arrangement of circular muscle fibres served the purpose of a sphincter to facilitate the process of mixing the bile and the pancreatic juice in the duodenum; which has been so perfectly described by Cannon.

The presence of a gastric ulcer in a considerable proportion of patients that have suffered from chronic appendicitis may have some relation to this condition in the following manner: There is undoubtedly an obstruction of the ileocecal valve, due to the physiological contraction of this sphincter during an acute exacerbation of appendicitis, for the purpose of establishing a condition of rest in this vicinity. This is followed by nausea and vomiting, and it seems reasonable to suppose that the ileocecal valve initiates return peristalsis and that this in turn excites a contraction of the duodenal sphincter and the pyloric sphincter, and that in this way a normal passage of food from the stomach into the intestines is interfered with, causing an accumulation of residual food in the stomach, and that the irritation caused in this manner may be an etiological factor in the production of gastric ulcer. It may also explain the presence of bile in the vomitus of patients suffering from intestinal obstruction.

ABSCESS OF THE LIVER

Cases of suppuration in the liver, other than those found in tropical countries, are usually due to metastases of pyemia.

Dysentery is far the most frequent cause of abscesses of the liver. They

are very common in the tropical countries where the various inflammatory conditions of the bowels produce a thrombo-phlebitis of the mesenteric vein; the clots decompose, become dislodged and carry the infection through the branches of the portal vein, resulting in abscesses of the liver.

The amebæ dysenteriæ have frequently been found in the pus from these abscesses.

Liver abscesses, other than those occurring during the course of dysentery, may be due to gall stones, typhoid fever, intestinal ulcers, inflammation in region of the portal vein, trauma, syphilis and also as one of the complications following a suppurative appendicitis. It also has resulted from actinomycosis of the liver.

Symptoms. The most constant symptoms are, first, a history in which dysentery and chill appear; second, general malaise pronounced; third, pain and tenderness over liver; fourth, enlargement of the liver; fifth, hectic sweats, and rigors; sixth, right-side posture; seventh, erratic temperature running from 96.5 to 103.5° F.; eighth, progressive emaciation; ninth, gastric disturbances.

Pain in region of liver is usually an early and prominent symptom. The pain often follows the course of the phrenic and fourth cervical nerves and radiates toward the right shoulder. It is usually constant from the onset. By carefully noting the exact limits of the pain and tenderness the abscess may often be located. Pain is always increased by digital pressure.

Enlargement of the liver is perhaps the most invariable objective symptom, and usually causes a bulging of the right hypochondrium. The enlargement may take place in any direction. The expansion takes the course of the least resistance and may be the means of determining the seat of the abscess.

Prognosis. The prognosis is unfavorable especially in cases of multiple abscesses. The patient may succumb to the primary infectious disease, or to pyemia or sepsis, or the abscesses may rupture into the peritoneal cavity, causing a septic peritonitis, or may rupture into the pleural cavity resulting in septic pneumonia.

Treatment. The treatment is operative. The liver must be reached by crossing either the pleura or the peritoneum, the route chosen according to the location of the abscess. If there is reason to believe that the abscess is not pointing toward the pleura, or has not ruptured into it, the liver is reached through the peritoneal cavity by making an incision high up through the right rectus abdominis muscle. The abdominal cavity is carefully walled off by gauze pads. If the abscess is not readily discovered, the liver may be explored by means of an aspirating needle. The abscess is then incised freely and the cavity packed with iodoform gauze. Other pieces of iodoform gauze are so arranged as to protect the general peritoneal cavity and brought out through the incision.

In cases in which the abscess is evident on exposure of the liver, the operation may be done in two stages. The surface of the liver at the point of suppuration is exposed, and the wound packed with iodoform gauze and left three or four days until adhesions have formed, and then the operation is completed.

In passing through the pleura, it is necessary to resect one or more ribs. When the parietal pleura is incised its edges are caught by hemostatic forceps. The diaphragmatic pleura is now incised and its margins sewed to those of the parietal pleura so as to close the pleural cavity. The operation is completed by incising through the diaphragm and draining the abscess freely.

In cases in which there is redness and edema of the skin, making it evident that adhesions exist, the abscesses may be incised directly.

HYDATIDS OF THE LIVER

This disease is caused by a parasite known as the tenia echinococcus whose normal habitat is in the intestinal canal of dogs, jackals and wolves.

The disease is most prevalent in Australia and Iceland, where the natives are not cleanly and live in close association with dogs.

The tenia are taken into the alimentary canal with the food, or more commonly with drinking water. According to Fowler their albuminous envelope is partly digested in the stomach, and thus set free they burrow into the tissues and most frequently enter a radicle of the portal vein and are thus carried to the liver.

There is some question as to what becomes of the liver tissue where these large cysts develop in the organ. Some authors believe that an atrophy takes place, while others think that a hypertrophy occurs.

When the cyst is fully developed there is a sac filled with fluid in which float smaller cysts known as daughter cysts, and sometimes there are tertiary cysts inside of these.

The hooklets of the parasite are usually found in the cyst wall.

The cyst may exist for many years and only be discovered at autopsy. The great danger is that they may rupture. However, this is not necessarily fatal, as they may rupture externally or into the intestinal canal. A cure may result in this manner. If the rupture occurs into the pleural cavity, gall bladder or peritoneal cavity, it is almost invariably fatal. If infection occurs, the disease may resemble a liver abscess.

Symptoms. The symptoms vary according to the size and location of the cyst. When large and near the surface it may be felt as a globular tumor, rather elastic and sometimes fluctuating. If the tumor is behind the liver, there may be no symptoms at all. Most patients complain of a sense of distress and weight in the hepatic region. As the tumor grows there may be pressure symptoms, as dyspnea and cough from extension upwards to the diaphragm. Pressure on the portal vein may result in ascites, jaundice or hemorrhoids. The hydatid fremitus is seldom present. It is only present when the daughter cysts swim in the fluid.

Diagnosis. The diagnosis is often difficult, as many of these patients may remain in good health for years. It may be differentiated from cancer and abscess by the long history, slow growth, the absence of loss of weight and the lack of the pronounced constitutional symptoms present in abscess. Its shape and absence of biliary symptoms rule out gall bladder disease. The fact that the colon does not overlie the tumor, rules out cystic or sarcomatous kidney.

The complement fixation test has proved of striking value in the diagnosis of these cases. The patient's serum is tested for antibodies, precisely as in the Wassermann test, save that echinococcus cyst fluid (from slaughter house) is used as antigen.

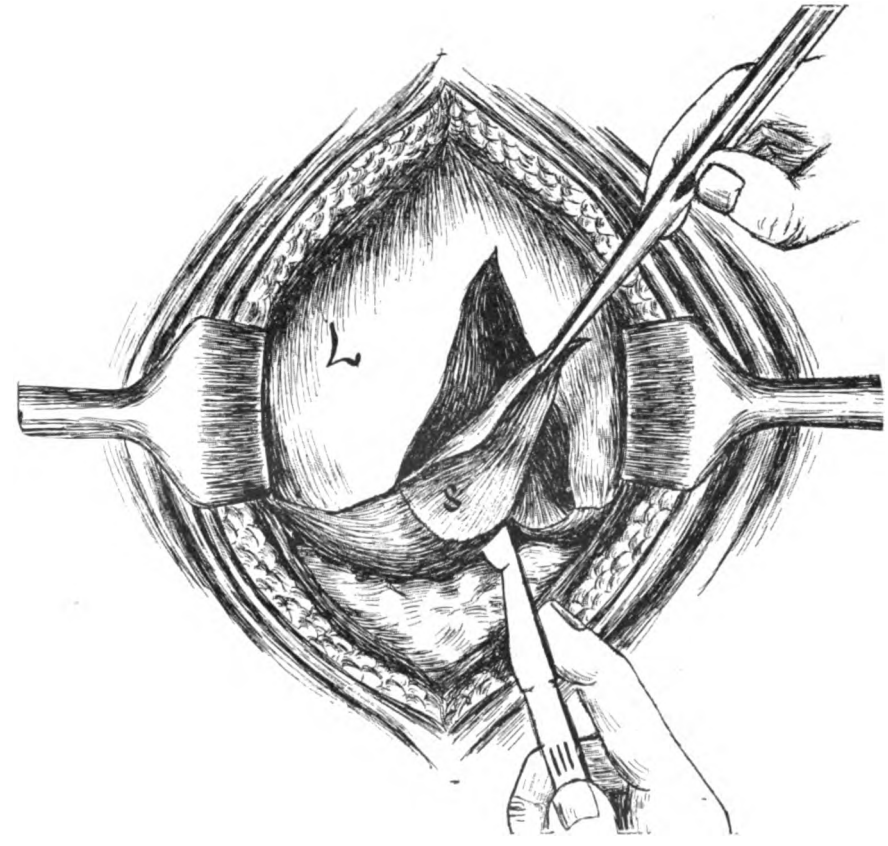
An interesting diagnostic point in palpating an hydatid cyst is a peculiar vibration that persists for quite a while after tapping against the tumor. The vibration is due to the motion set up in the daughter and grand-daughter cysts.

Treatment. The treatment consists of evacuation of the cyst contents and removal of the lining of the cyst cavity and drainage of its cavity, or, in a few selected cases where the cyst is pedunculated, excision of the entire cyst.

The operation of drainage of the cyst may be done in two stages, after the method of Volkmann, which consists of opening the peritoneal cavity and placing sterile gauze pads between the cyst wall and the peritoneum to cause adhesions to form between the liver and the peritoneum, or suturing the cyst wall to the peritoneum, and three or four days later opening and draining the cyst.

The operation most commonly done consists of making an incision over the most prominent part of the swelling, then carefully packing away the stomach and intestines with sterile gauze pads; a trocar is inserted into the cyst and as much fluid as possible is withdrawn. The cyst is then incised and the remainder of its contents sponged out. The lining of the cyst, which is known as the parasite endocyst, is removed. The edges of the cyst are sutured to the peritoneum and the cyst cavity packed with gauze.

The after-treatment consists in gradually diminishing the amount of packing at each dressing until the cyst cavity is obliterated.



L, Liver. S, Section Removed. (Frank.)

INJURIES OF THE LIVER

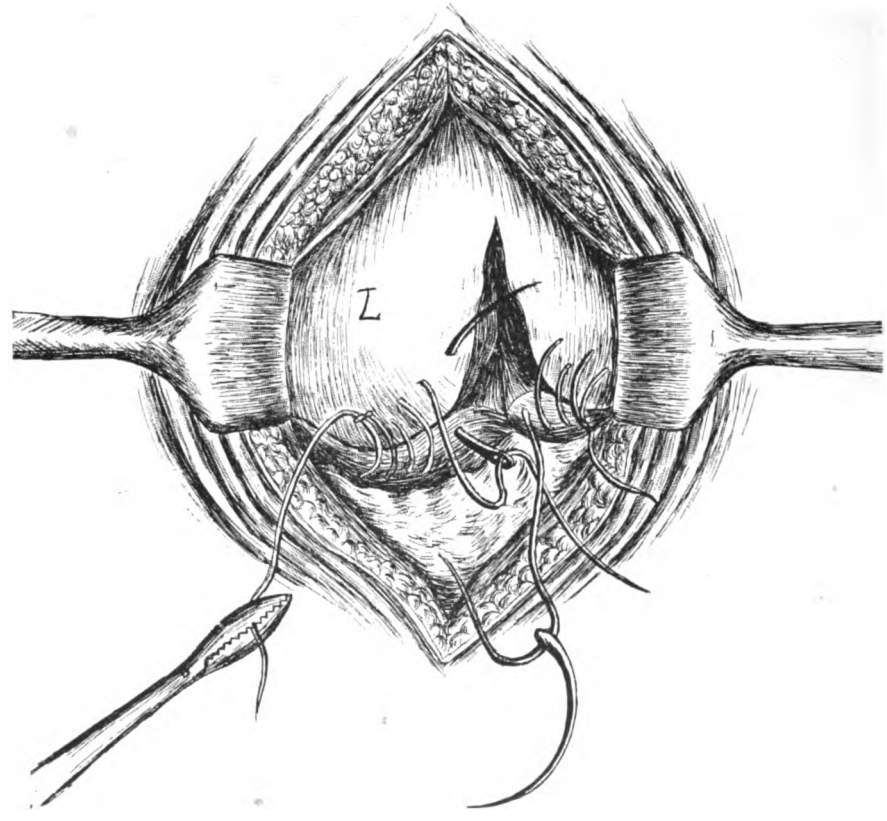
The liver is apt to be injured by crushing accidents, as when a heavy wagon wheel passes over the body; also by blows or falls which break one or more ribs, which puncture the liver, or from penetrating wounds.

The symptoms of rupture of the liver are those of internal hemorrhage and severe shock, such as extreme pallor and cold skin, feeble and rapid pulse, sighing respiration; the abdomen becomes swollen and tympanitic and sometimes there is dullness from the collection of blood. Often there is vomiting, thirst and syncope.

Treatment. The treatment should be directed toward the control of hemorrhage as soon as possible and to prevent the retention of bile in the peritoneal cavity on account of its liability to cause cholemia.

If from the site of injury it is thought that the injury to the liver is in the left lobe, or is undetermined, it is well to make a median incision.

In wounds of the right lobe a longitudinal incision is made through the outer edge of the right rectus abdominis muscle and then, if found necessary, this may be converted into the "S"-shaped incision, as suggested by Bevan, or into the Robson incision.



L, Liver with Wound Partially Sutured. (Frank.)

Wounds of the liver may be treated by suture or cautery or by gauze tampon, or by suturing a piece of sterile gauze down upon the bleeding surface.

In the majority of cases a little pressure by means of a gauze pad for a few minutes will control the hemorrhage. In some cases it may be necessary to make continuous pressure over the bleeding surface. This may be done by suturing a piece of iodoform gauze over the bleeding surface by a few catgut stitches and bringing one end up through the abdominal wall. The gauze will make continuous pressure and the stitches will prevent the displacement of the gauze should the patient cough or vomit. The catgut will be absorbed in a few days so that the gauze may then be readily removed. Bleeding may also be controlled by suturing the liver, using a non-cutting needle threaded with catgut. The sutures are passed directly through the liver substance, then

tied just tight enough to bring the edges of the liver together (the blood pressure in the liver is very low and is controlled by slight pressure).

In large wounds with considerable destruction of liver tissue it is better to use the method of suture devised by Frank. This consists in the excision of a portion of the liver, as shown in the plate, removing a wedge-shaped piece, leaving the organ with two flaps forming a trough. If there is much bleeding from the cutting of the liver tissue, it is controlled by ligating the bleeding vessel, or by passing a mattress, catgut suture through the entire thickness of the liver surrounding the vessel. The flaps are now coaptated. For this purpose a long, non-cutting needle is threaded with catgut and a running stitch is commenced at one end and continued, as follows (see plate): One suture is carried through the liver tissue near the bottom of the trough and then one superficially, and so on alternating. The stitches should not be tight, but drawn just enough to bring the two tied flaps together in perfect coaptation, obliterating all dead space. The continuity of the liver surface is re-established and no raw surface or ragged edge is left.

PART VIII

SURGERY OF THE GENITO-URINARY TRACT

General remarks. In considering the surgery of the kidney especial stress should be laid upon diagnosis, because this is really the most difficult task connected with the subject. The examination of urine is most important, but it does not in itself result in a definite surgical indication. The presence of albumen, tube casts and characteristic epithelial cells from the kidney indicate nephritis in one or both kidneys, but it does not make a surgical diagnosis. The presence of blood or pus indicates a bleeding or suppurating point in the kidney, the ureter, the bladder or the urethra, but again it does not definitely locate the diseased region; consequently these findings can act only as corroborative evidence and serve but to confirm a diagnosis made without their aid. It is in such cases that it is important to obtain the urine from each kidney separately, so as to locate the source of these substances and determine the diseased organ. At the same time it is possible to learn whether the other kidney is sufficiently active to be depended upon to perform the entire work. In the female this can be done with comparative ease through a large speculum, the patient being placed in the knee-chest position and the bladder permitted to inflate itself with air, which it does spontaneously whenever a speculum is inserted with the patient in the position named. In the male, it may be accomplished by the aid of a cystoscope.

It is, however, to be remembered that the opening of the ureter into the bladder is a delicate mechanism which frequently prevents infectious material existing in the bladder from infecting the ureter and the kidney for a long period of time, and also that in cases in which one suspects a diseased kidney the bladder is very frequently not aseptic and one consequently runs the risk of infecting the other kidney also by carrying septic material from the bladder into the ureter. Moreover, it is likely that after the ostium of the ureter has once been distended for the introduction of a ureteral catheter it may no longer be so certain to guard against infection of the ureter and kidney from the bladder. We have observed infections of the kidney in a considerable number of cases from the practice of ureteral catherization. It therefore seems at the present time to be an unwarranted procedure, except in the hands of surgeons especially trained in the use of the cystoscope and the ureteral catheter; and then only when needed to make a diagnosis in cases in which a positive determination is of importance and cannot be made without recourse to this method.

CYSTOSCOPY

Direct vision of the bladder by means of an electrically lighted instrument has been used in our clinic during the past four years in over 500 examina-

tions, and has proven a worthy aid in diagnosis when used in conjunction with the history and physical findings in the case.

Indications. The cystoscope is of value in diagnosing such conditions as cystitis, tuberculosis, ulcer, papilloma, carcinoma, or stone of the bladder. Ulcers and tuberculous inflammation can be treated by local injections of strong silver salts. Papillomata and early primary carcinomata are cauterized by means of a fulgurating current. A bladder or ureteral stone can often be grasped by a forcep and removed directly, if not too large. Some large stones are soft enough to be crushed and washed out as sand. When a stone is larger than .8 cm. and too hard to be crushed, it can be removed only through a cystotomy. By watching the condition of the ureteral openings and the character of flow of urine coming from them, much can be learned of the functions of the kidneys. In cases of obstruction of the ureter, due to conditions such as calculus, non-shadow-giving concretion, or kink; or in the diagnosis of hydronephrosis or of renal tuberculosis, the ureters may be catheterized and separate specimens of urine collected. Radiographs may be made with the bismuth-impregnated catheters in position in order to demonstrate the course of the ureters. We have made a very few pyelograms, as we consider the injection of the pelvis of the kidney with silver salts a frequently dangerous and usually unnecessary procedure.

Contraindications. A radiograph should always first be made in cases of suspected renal, ureteral or cystic calculus. When the stone is definitely shown by the radiograph, it is usually unnecessary to use this method. It should not be used in very hypersensitive individuals; or, at least, the examination should be made as rapidly as possible consistent with thorough observation. In cases of active cystitis or urethritis, the ureters should not be catheterized, as an ascending pyelonephritis may result.

Instruments. In all of our cystoscopic work we have used but one instrument, that devised by Dr. Braash of the Mayo clinic, and it has been entirely satisfactory in all instances. It is a direct vision type, there being no lenses to distort the view, and it is very simply constructed and durable. Only one insertion of the instrument is necessary for viewing, catheterizing the ureters, fulgurating or removing stones; a fact of prime importance, especially in the male. The following is a list of instruments which we use:

1 Braash cystoscope complete with double catheterizing tube.
3 extra tungsten lamps.
1 current rheostat and attaching cord.
2 No. 5 Porges bismuth impregnated ureteral catheters.
1 fulgurator-generator (Wappler).
1 fulgurating wire.
1 operating forcep.
1 glass jar for formalin sterilization of instruments.

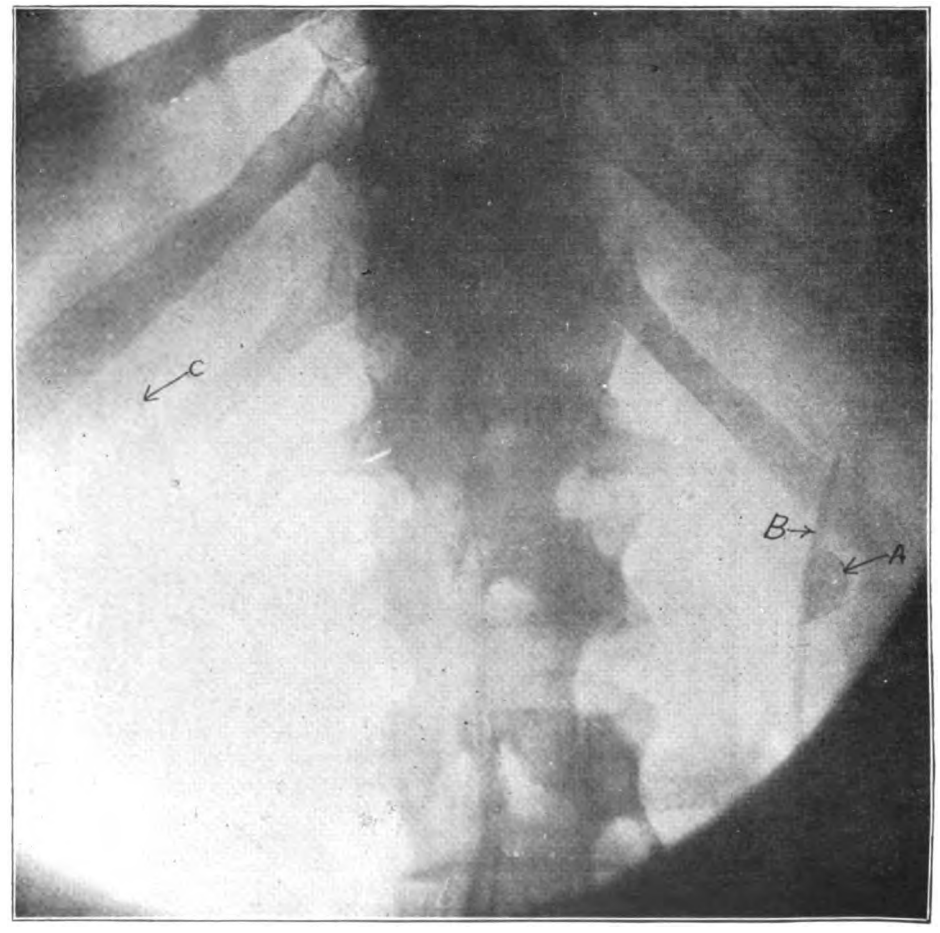
Solutions:

Glycerine.
10 per cent. cocaine.
1 per cent. alypin.
2 per cent. boric acid.

Preparation of instruments. All but the glass-containing metal instruments may be sterilized by boiling for one-half hour. Those containing glass may be placed in phenol 95 per cent. for five minutes, then in alcohol 95 per cent., followed by rinsing in sterile water. Or, better still, all instruments, except the catheters, are well washed with warm soap suds, rinsed, and

placed in an upright jar containing strong fumes of formaldehyde. This can be accomplished by allowing a piece of gauze soaked with commercial formalin to remain in the bottom of the jar. The catheters are siphoned with 2 per cent. cold boric acid solution and put away in a cool place. When ready to use they are placed in a sterile bowl containing 4 per cent. boric acid solution.

The most aseptic precautions are indicated throughout the examination and great care must be exercised not to traumatize the parts in the least. If



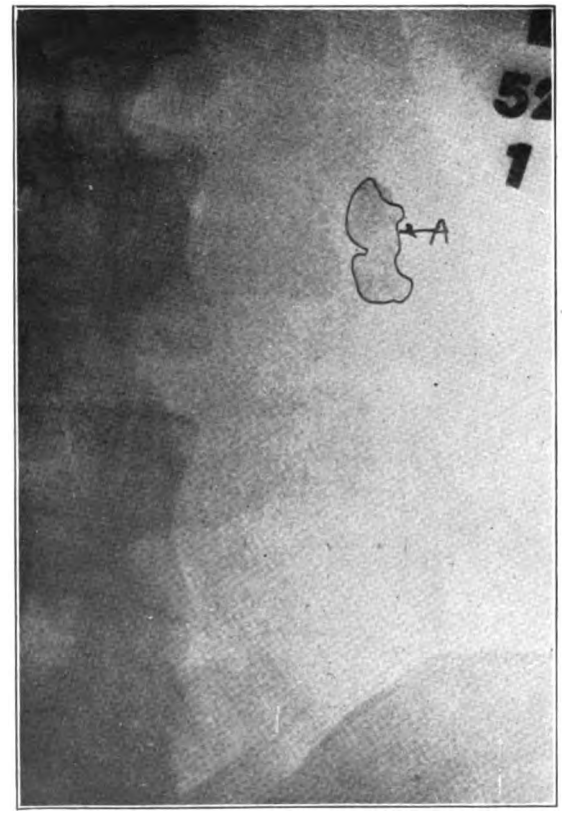
RENAL STONE (A) IN PELVIS OF LEFT KIDNEY. (B) CATHETER IN LEFT URETER AND KIDNEY. (C) CATHETER IN RIGHT URETER AND KIDNEY.

these precautions are not observed, annoying inflammations may result that are worse than the original condition.

The bowels should be thoroughly cleansed by means of two ounces of castor oil followed by a large soap suds enema. This procedure is necessary in all cases in which radiographs are to be made during the course of the examination. In extremely sensitive individuals, or in those with severe pain

in the region of the urethra not controllable by the use of cocaine, it is best to anesthetize, preferably with ether. It is very seldom the case that general anesthesia is necessary. However, when it is known that an operation is to be performed after the examination, the patient is always anesthetized before beginning. The patient is instructed to empty the bladder just before, in order to determine the amount of residual urine. One-half hour before beginning it is well, especially in male patients, to give an hypodermic injection of $\frac{1}{6}$ or $\frac{1}{4}$ grain of morphine.

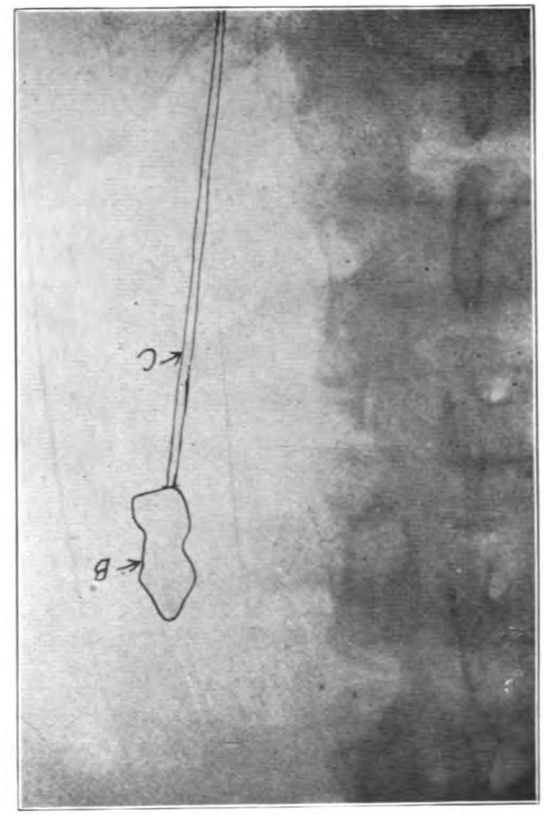
The external genitals are thoroughly cleansed with sterile soap suds and water, as are the operator's hands. In fact, the aseptic precautions must be



SHADOW IN REGION OF LEFT URETER.

as great as in a major surgical operation. A small pledget of cotton soaked in 10 per cent cocaine solution is placed in the external urethral meatus for a period of five minutes and then removed. A male catheter, lubricated with sterile glycerine, is passed into the bladder and the residual urine drained and saved for examination. Through the catheter one ounce of a 1 per cent. solution of alypin or 2 per cent. cocaine is injected and the catheter removed. The current rheostat is adjusted to give the proper intensity of light, the obturator is placed in position, the end covered with sterile glycerine, and it is then ready to be passed. In females there is no difficulty in passing the

instrument; in males, however, it is sometimes necessary to pass sounds in gradually increasing sizes in order to dilate strictures that may be present. The obturator is now withdrawn, the window placed in position and the bladder irrigated through the instrument (with 2 per cent. warm boric acid solution held in a glass vessel placed 4 or 5 feet above the patient). The window is next placed in position and the electrical connection made. The bladder is then distended to the point of beginning distress, when the flow of boric solution is discontinued and a little allowed to escape. When vision through the viewing tube is clouded, due to sediment or blood from the bladder, a small amount of solution is allowed to run through, in order to



CATHETER PASSED (C) WITH OBSTRUCTION AT THE STONE (B). DIAGNOSIS IN THIS WAY MADE CERTAIN.

clear the tube. The bladder may now be routinely examined, beginning with the fundus, then the two sides, and finally the trigone. The line of junction between the trigone and bladder mucosa proper is usually clearly seen, and by pointing the cystoscope to this line and following it as far as it goes to the right, the right ureteral orifice is found. In the same way the left ureter is found. Occasionally the ureters cannot be found because of the general ruggedness of the bladder, due to a chronic cystitis or to tuberculosis. Both openings are described and the flow of urine from them observed. If no more is to be done, the fluid is allowed to escape and the cystoscope slowly

removed while the urethra is carefully examined throughout its entire extent. A soft rubber catheter is reinserted and one-half ounce of 5 per cent. argyrol solution instilled. The catheter is then removed. It is a good plan to give 5 grains of quinine by mouth at this time in order to prevent a possible instrumental chill.

Catheterization. In order to catheterize the ureters, the cystoscope is passed as above described and the ureteral openings found and examined for spurts of urine. The window is then removed and the double catheterizing tube inserted. Through the small tubes are inserted two No. 5 bismuth impregnated ureteral catheters. The catheter is then pointed upward and outward and passed through the ureteral orifice. Under constant observation the catheter is inserted as far as it will go. As soon as the least resistance is encountered to the passage of the catheter, great care should be used in order not to perforate the ureter or pelvis of the kidney. Undue force should never be used to insert the catheter. Often it can be felt that the catheter passes a definite partial obstruction, which distance is measured on the catheter. Such obstruction may be a stone or kink in the ureter. The other ureter is then catheterized in the same way and the cystoscope withdrawn, the two catheters being left in position after leaving some mark on the distal end of one catheter to distinguish right from left. The urine may now be collected from the separate kidneys and the catheters withdrawn by gentle traction. Or, a radiograph may be taken with the catheters in position, after which they may be removed in the manner just described. Stones may sometimes be removed from the ureter by injecting and dilating the ureter below the obstruction with glycerine through a ureteral catheter. A stone that has become lodged at the ureteral orifice can usually be removed by means of a forcep introduced through the cystoscope.

Fulguration. Papillomata of the urinary bladder are more frequent than was formerly supposed, and often produce distressing symptoms. The ideal treatment of these benign tumors is by cautery with the fulgurating current. This is a special form of high frequency current which allows of a hot spark to pass from a metal conductor through a fluid, such as salt solution, to a portion of tissue. The patient is made a conductor of the current by attaching one pole of the fulgurator by a wire to a tin plate placed between the table and buttocks. The other pole is attached by a wire to an insulated wire passing through the catheterizing tube of the cystoscope. A portion one mm. in length, of the end of the latter wire is laid bare and approximated to the tumor. The current is controlled preferably with a foot switch. As the tissues are cauterized they become white, and usually the greater part, if not all of the mass, can be eliminated at one time. Otherwise, the procedure can be repeated in ten days, being certain that the entire base is thoroughly cauterized. This is the most satisfactory cure of benign papillomata that we know of, and some of our cases have remained well during four years.

INFECTION OF THE KIDNEY

Typical history. The patient, a married woman thirty years of age, gives the following history: In good health as a child. Began to menstruate at fourteen; regular; painless. Married at twenty-two. Two pregnancies; labors normal. Second child four years ago. Has never felt well since. She had difficulty in emptying the bladder after the child-birth. On the eighth day after confinement she was taken with severe pain in right side of the abdomen, which lasted for about three months. Since then has had numerous attacks of pain in the same region, with intervals varying from one week to two months. Attacks vary in severity. Has often been confined to bed, and the attacks have been accompanied by fever and vomiting. The attack lasts from a few hours to three days. The patient is often jaun-

diced during these periods. About four weeks ago this patient was taken with pain in the right side, accompanied by a severe bearing-down sensation. At this time she noticed a mass in the right side of abdomen the size of an orange. Has had no vomiting and does not think she has had much temperature with this attack. The pain has been almost constant up to the present time, but the tumor has decreased somewhat in size.

Present condition. Greatly emaciated, appetite good, heart and lungs normal. Abdomen scaphoid. A fluctuating mass, somewhat tense, extends from the right costal arch to a little below the umbilicus inward to the median line. It is plainly palpable on bimanual examination with one hand in the lumbar region and one on the abdomen. It is quite tender and seems to move slightly on deep inspiration. The perineum is slightly lacerated; cervix also slightly torn. The cervix is long and hard. The uterus far down in pelvis, normal position, fornices empty, adnexa apparently not connected with mass above.

During the paroxysms or period of illness there is always an increase in the size of the swelling and a decrease in the flow of urine, but the latter is less turbid at such times. As the flow increases and becomes more turbid the patient's condition improves and the swelling decreases in size.

The heart and lungs are normal. The urine contains a considerable amount of pus, but is otherwise normal. Upon examining the urine from the two kidneys separately, by means of the Harris segregator, it is found that the fluid secured from the left ureter is normal, while that from the right kidney contains pus. The microscopic examination of the urine has failed to demonstrate the presence of tubercle bacilli.

Diagnosis. The swelling is located in the vicinity of the right kidney and the ascending colon. Frequently an appendix is located as high up and sometimes a gall bladder is located as low down. The presence of jaundice and the persistent gastric disturbances might indicate an empyema of the gall bladder, or gall stones. The same conditions frequently occur in the case of a chronic retro-cecal appendicitis. A tuberculosis of the ascending colon with adhesions between the omentum and transverse colon might cause the same symptoms. The two elements, however, which seem to establish the diagnosis are: 1. The fact that there is pus in the urine coming from the right kidney, and, 2. The fact that the condition is evidently the result of a puerperal infection which first affected the bladder and then the ureter, and, by way of an ascending infection, the kidney. This is still further confirmed by the regular variations in the size of the swelling and by the synchronous changes in the character of the urine. The patient lived in a small town in the mining regions at the time of her confinement, where she could not obtain medical care and good nursing; hence it is likely that there remained residual urine in the bladder for a considerable time and that the pelvis of the kidney was greatly dilated by the return pressure. The infection of the pelvis of the kidney probably occurred on the eighth day after confinement, when the patient suffered the severe pain.

So long as there was fairly good drainage from the distended pelvis of the kidney through the ureter, there were no serious symptoms, because there was but a slight amount of absorption, the pus being diluted with urine constantly secreted. But as soon as the ureter became temporarily blocked by an accumulation of thick pus, or on account of edema, the confined urine became more septic and absorption more extensive. The increased pressure increases the pain, and the absorption increases the temperature. The gastric disturbance can be accounted for by the same conditions. Jaundice frequently accompanies abscesses of the kidney or the appendix, without direct involvement of the liver or the biliary tract, although these parts are frequently involved secondarily. The most important point in determining the differential diagnosis, however, is the demonstration of pus in the urine from the right kidney, and normal urine from the left. We can consequently make a positive diagnosis of pus in the pelvis of the right kidney without being able

ATROPHY OF KIDNEY STRUCTURE WITH THE FORMATION OF A LARGE CYST. DILATATION OF THE URETER FROM OBSTRUCTION.

to positively exclude the presence of disease in the vermiform appendix, the gall bladder and biliary ducts.

The disease has existed for four years and the history of the case shows that the infection has probably extended upward through the ureter from the bladder. It is difficult to determine in any given case what secondary conditions may have resulted in this period of time. The fact that aside from the presence of pus the urine is nearly normal would indicate that no great amount of destruction of kidney tissue had occurred, but that the disease is chiefly confined to the pelvis of the kidney.

Obstruction to the flow of pus and urine from the right kidney during periods of exacerbation of the disease might indicate an obstruction of the ureter due to the presence of a renal calculus, which could readily have formed with the conditions present in this case, or an occlusion due to the presence of thickened pus or to an edema, or to an acute bend in the ureter, or through the presence of an abnormally placed blood vessel compressing the ureter. In case the obstruction is due to a calculus the relief which occurs when the calculus is displaced is usually much more sudden and more complete than it was in this case. Obstruction from an acute bend of the ureter occurs only in cases in which the kidney is abnormally movable, which is not evident in this patient. However, so far as the treatment and the prognosis are concerned, it is immaterial to the patient whether this part of the diagnosis be made before or during the operation.

Indications for operation. It is plain that unless this patient obtains relief from her present condition she will continue in her downward course, which has become more and more marked as time has progressed during the past four years. The constant absorption of pus will not only continue to jeopardize her nutrition by interfering with her appetite and her digestion indirectly, but it will undoubtedly result in amyloid degeneration, especially of the kidneys and the liver. The constant presence of pus in the bladder is likely to result in an infection of the pelvis of the left kidney, which has as yet escaped. Sooner or later, the tissues of the kidney itself will become inflamed, and then only the left kidney will remain to perform the labor of both organs. Aside from this there is always the danger of metastatic infection of other parts of the body from the presence of this accumulation of pus, either by extension or by metastasis, because this is possible in case of an accumulation of pus in any part of the body if the drainage is not perfect. The only way in which relief can be obtained is by direct drainage by means of a free incision.

Preparation for operation. In order to insure against an accident occurring rather frequently after operations upon the kidney—which consists in a complete absence in the secretion of urine by both kidneys and consequent uremia —it is wise to provide for very free elimination before the operation is performed, first, by the administration of cathartics, and, second, by having the patient drink great quantities of distilled water, preferably hot. In the meantime the patient is placed for a week upon a simple milk diet.

In order to increase the activity of the glands of the skin, she will receive warm baths daily. On the day before the operation two ounces of castor oil will be given as usual. In this way it is possible to place the patient's kidneys in a fairly safe condition even where there has been much impairment of their function.

Technique. The operation must primarily be exploratory, because the state of the kidney must determine the course to be employed. If the condition of the kidney is such as to preclude the possibility of its restoration to normal, as a result of a conservative operation, then its removal is indicated, because the examination with the Harris segregator has demonstrated the fact that the

left kidney is normal. On the other hand, if it is possible to preserve the kidney this must by all means be done. Were the other kidney not normal, it would not be wise to remove the diseased one, so long as any portion of it remains capable of excreting urine, even though it might not be possible to obtain a perfectly normal kidney as a result of the operation, because a patient can live longer with two impaired kidneys than with one.

Were this patient suffering from a tuberculosis of this kidney our position would be quite the reverse, because then we would remove this kidney even though it might not be seriously diseased, as if a tuberculous kidney is simply drained the other kidney is almost certain to become involved, while if it is removed the physiologic increase in the circulation of the second kidney seems to overcome a slight amount of tuberculosis after the first kidney has been removed.

Beginning at a point near the twelfth rib an incision is carried downward towards the crest of the ilium through the edge of the erector spinæ and quadratus lumborum muscles, being careful to distinguish the ilio-hypogastric nerve and to retract it forward in order to avoid injuring it. It is well to make a free incision in order to expose the kidney well for palpation and inspection. This exposes the fat capsule of the kidney. Were we not practically certain of the presence of pus in this kidney, the condition of the vermiform appendix and the gall bladder could be determined with ease and safety by perforating the peritoneum in front of the ascending colon and making a digital examination of these organs.

The appendix can readily be removed through this incision, unless it is too extensively adherent, and it is also possible to remove gall stones from the gall bladder through the same incision, although the incision which has been described before is much to be preferred.

In this case, however, opening of the peritoneum would not be proper, as it would increase the likelihood of an infection of the peritoneal cavity.

The fat capsule is opened and a dark, oblong organ is seen in the wound. Grasping this between the fingers it is found to fluctuate. This is undoubtedly due to the presence of pus in the dilated pelvic cavity. An incision two inches in length is made through the cortex of the kidney a little behind the center of its convex surface, which is the least vascular portion of the organ. Immediately there is a free flow of pus diluted with urine. The finger is inserted into the pelvis of the kidney and this cavity is carefully palpated, each calix being explored with the finger, in order to determine the presence of a renal calculus. The entire pelvis is lined with granulation tissue and there is a considerable amount of thickening of the tissues of the pelvis. The cortex of the kidney is thin and somewhat congested, but otherwise normal. A large probe with a bulbous end is introduced into the ureter and this is found free from obstruction by a stone.

A catheter is now introduced into the bladder through the urethra and held closed, then a small catheter is introduced into the ureter through the kidney. The urine is permitted to flow from the catheter in the bladder and simultaneously a one-half per cent. solution of methyl blue is injected into the other catheter. At once the urine takes a blue color showing that at the present time the ureter is open.

It seems likely that drainage of the kidney would result in restoration to a fairly normal condition, and that the kidney will ultimately become nearly as useful as its fellow.

In order to stimulate the healing of the pelvic cavity, and at the same time establish free drainage, the pelvis will be tamponed carefully with iodoform gauze. A rubber drainage tube will also be inserted into this cavity, the gauze being tamponed around this. The drainage tube and gauze are carried out

through the wound and the latter is sutured above and below it. A large dressing applied to the surface completes the operation.

In case a kidney has been split longitudinally, as in this case, and the pelvis has been found to be in an aseptic condition, which is not infrequently true in cases in which a uric acid or an oxalate of calcium calculus is found, it may be unnecessary to tampon the pelvis of the kidney with gauze. In these cases it is well to insert a Jacob's retention catheter into the lower end of the wound and to suture the remaining portion of the wound with catgut sutures passed through layers of iodoform gauze placed upon the flat surface of the kidney on either side to prevent the sutures from cutting.

After-treatment. Occasionally a hemorrhage occurs upon removing the tampon which has been placed in the kidney, because the blood vessels in this organ are characterized by especially thin walls, making their closure very unstable. On this account it is wise to postpone withdrawing the tampon until it has been loosened by the development of granulations. It may be removed a little at a time until it has all been loosened. In the meantime the urine drains through the wound and the mucous membrane lining the ureter has an opportunity to become normal, because the flow of pus and urine through this canal no longer causes an irritation.

In cases like the one instanced the urine usually becomes clear in a few days, as the drainage through the wound is so free that there is no accumulation. The pelvis of the kidney, which has been dilated for a long period of time, becomes contracted for the same reason, and all of the conditions become more nearly normal in a comparatively short period. It is wise to continue the drainage until there is no doubt but that the pelvis of the kidney and the ureter are nearly normal, so that natural drainage will be established.

Use of distilled water. The patient should receive an abundance of distilled water at intervals of one to two hours regularly, in order to dilute the urine, which will form a non-irritating fluid as it passes over the diseased surfaces. In pyelitis, and in fact in other conditions, such as renal calculi, in which the pelvis of the kidney is diseased, distilled water given internally in considerable quantities is a most useful remedy. Many patients who have suffered for years from renal colic are permanently and perfectly relieved by this simple means. It seems necessary for the urine to possess a certain concentration in order to make the formation of renal or cystic calculi possible in the absence of foreign bodies, which may account for the clinical fact that has just been mentioned. The free use of distilled water results in diluting the urine to such an extent that renal calculi or renal sand no longer form. Moreover, the urine becomes exceedingly bland and non-irritating, and we have frequently observed not only a relative decrease of the pus in the urine from dilution, but also an absolute decrease, as a result of drinking distilled water freely.

The formation of a fistula. In case the ureter does not become normal in a relatively short time, which may occur, especially where the disease has existed for a long period, the wound in the kidney will not heal, and a fistula may persist, which is not only disagreeable because the dressings are constantly wet, but which results in an excoriation of the skin on account of the irritating effect of the urine with which it is constantly in contact. In these cases, it is advisable to introduce a soft rubber retention catheter with a bulbous end, preferably,—described elsewhere in this volume as a Jacob's catheter,—into the kidney and to weight the free end by inserting a glass tube into it and then placing this in a bottle, which may be carried underneath the clothing, suspended from a belt. At night a longer rubber tube is attached to the catheter and its free end is passed out into a vessel outside the bed on the floor. This tube will act as a siphon and the patient will remain entirely dry.

Occasionally the ureter does not recover, and then it will become necessary either to remove the kidney or to be satisfied with the drainage which has been established, together with all of the resulting inconveniences.

The quantity and quality of urine secreted by the diseased kidney can now be easily determined, and it will be apparent from this whether the kidney should be saved. So long as the opening into the kidney is too large for the use of a retention catheter, the quantity of urine can be determined by weighing the dressings before they are applied and after they have been in place for a given time.

Response of the remaining kidney. It is, however, not safe to judge of the condition of the remaining kidney by the amount of urine secreted into the bladder from it, while all of the urine is siphoned out through the catheter in the diseased kidney. In one instance of this kind in which we removed the diseased kidney notwithstanding the fact that but 180 cc. of urine was secreted from the other kidney the latter at once became more active, secreting 400 cc. on the third day after the removal, then advancing slowly until 2,000 cc. were secreted daily within three weeks, then very gradually reducing to 1,500 cc. when the normal amount of liquid nourishment and water was taken. The case was one in which the uterus had been removed for carcinoma in a very weak, emaciated patient. The lower end of the right ureter being involved it was excised with the cautery. For several days both kidneys secreted a normal amount of urine, one secreting into the vagina, the other into the bladder. Then the one secreting into the bladder produced less and less, running as low as 100 cc. on some days. The patient's condition became worse constantly. At the end of six weeks she seemed in a hopeless state, when she developed a pyelitis and we were forced to choose between certainly losing her from the pyelitis with uremia and losing her most likely from shock and uremia after a nephrectomy.

The fact that the left kidney had secreted normal urine directly after the hysterectomy determined us to make a very rapid nephrectomy, with the result stated above. It is consequently not proper to judge entirely by the quantity the other kidney secretes under these conditions as regards its ability after the removal of the diseased kidney.

We have also been able to confirm the observation of others in cases of tuberculosis of the kidney, that the removal of one kidney would result in the secretion of more urine, and urine of a better quality, by the remaining kidney than was secreted by both before the nephrectomy was made.

In case of intermittent hydronephrosis, whether the urine be clear or mixed with pus, it is always important when the kidney is first exposed to determine the character of the obstruction. If this is due entirely to a kinking of the ureter from a dropping down of the kidney and the ureter is not equally mobile with the kidney, simply dividing the adhesions holding the ureter and fastening the kidney in place by nephrorrhaphy, as described elsewhere, will suffice. If the ureter is bent acutely over an aberrent blood vessel the latter should be caught between two pairs of forceps, cut and ligated, and nephrorrhaphy should again be performed. If the obstruction is due to a deformity of the pelvis itself then a plastic operation should be attempted, as originally recommended by Fenger. The method developed by Mayo, as illustrated in accompanying plates, is so satisfactory that we give it in full later on.

PERINEPHRITIC ABSCESS

While this condition most commonly results from stone, tuberculosis and pyonephrosis, it occasionally follows such seemingly slight infections as furuncles and felons. The abscesses follow small, metastatic infections in the kidney cortex, which rupture externally and infect the perinephritic fat.

When this occurs as a metastatic infection, the symptoms come on very suddenly and without any previous indications of renal trouble. The pain in the kidney region is intense but not of the colicky nature of renal colic. There is a marked tenderness in the renal triangle and rather early signs of edema in the lumbar region of the affected side. The urine is very apt to be negative, because unless the metastatic abscess ruptures into the pelvis of the kidney there will be no sign of pus in the urine. The temperature usually ranges from 102° to 104°, and an unusually high leucocytosis is found. Miller, of Philadelphia, places the average leucocyte count in perinephritic abscess at about 25,000.

The above symptoms, with the presence of a tender mass in the iliocostal space, renders the diagnosis quite clear.

The treatment should be instituted early and consist in simply making an incision over the kidney area and draining the abscess. These cases usually clear rapidly after simple drainage and make a complete recovery.

TUBERCULOSIS OF THE KIDNEY

The frequency of tuberculosis of the kidney seems to be on the increase, but this is undoubtedly due to the fact that the disease is being recognized more often in its earlier stages. Kroenlein has recently shown that nearly thirty per cent. of all surgical conditions of the kidney are tuberculous in origin.

The general opinion among surgeons seems to be that renal tuberculosis is usually unilateral in the beginning, and that if the diagnosis is made early extremely few cases of bilateral renal tuberculosis would be encountered. The physician is not always responsible for a late diagnosis because in many of these cases the symptoms are so slight that the patient does not consult a doctor until the disease is far-advanced in the kidney, or has invaded the ureter or bladder.

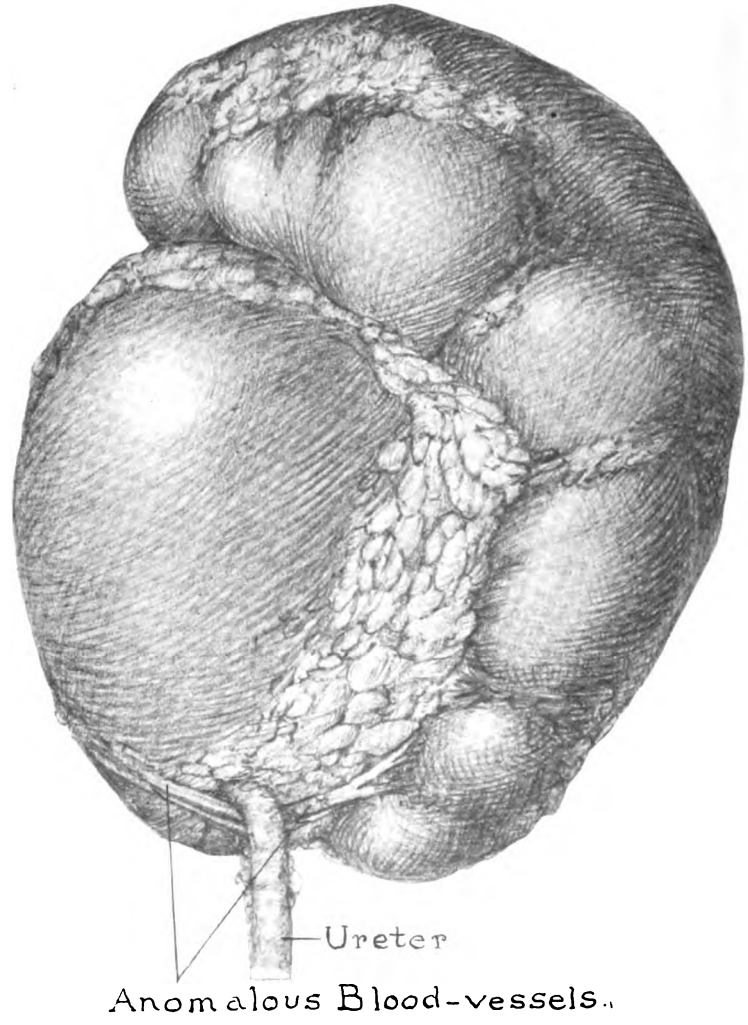
The most frequent among the early symptoms is hematuria which may occur without the accompaniment of pain. Polyuria is practically always present and remains constant. Pyuria and albumin are often present early but are apt to be intermittent. Reflex symptoms are quite pronounced, such as frequent urinations accompanied by burning sensations. Frequently all the symptoms are referred to the bladder and the physician may be misled into thinking the whole trouble is vesical in origin. Pain and tenesmus are not apt to be marked unless there is a high grade of inflammation present in the region of the trigone. The frequency of urination is present both day and night, and the burning on urination is constant. Colicky pain is rather rare but there is usually present a dull, aching pain in the loin. The temperature usually takes about the same course as in an early case of pulmonary tuberculosis. Tubercle bacilli are usually not found in the urine until after the appearance of pus therein. The use of the cystoscope and catheterization of the ureters, combined with radiography, is of great importance in the diagnosis of renal tuberculosis.

If the diagnosis is made before both kidneys are involved, the plan of treatment is very clear, which is early removal of the affected kidney.

The operation of nephrectomy, as described below, should be carried out in these cases, but should embody the following points: removal of the ureter as low down as possible and a thorough cauterization of the stump, and as complete a removal of the fatty capsule as feasible. The wound should be closed carefully without drainage, unless it seems probable that the parts have been contaminated at the time of operation.

NEPHRECTOMY

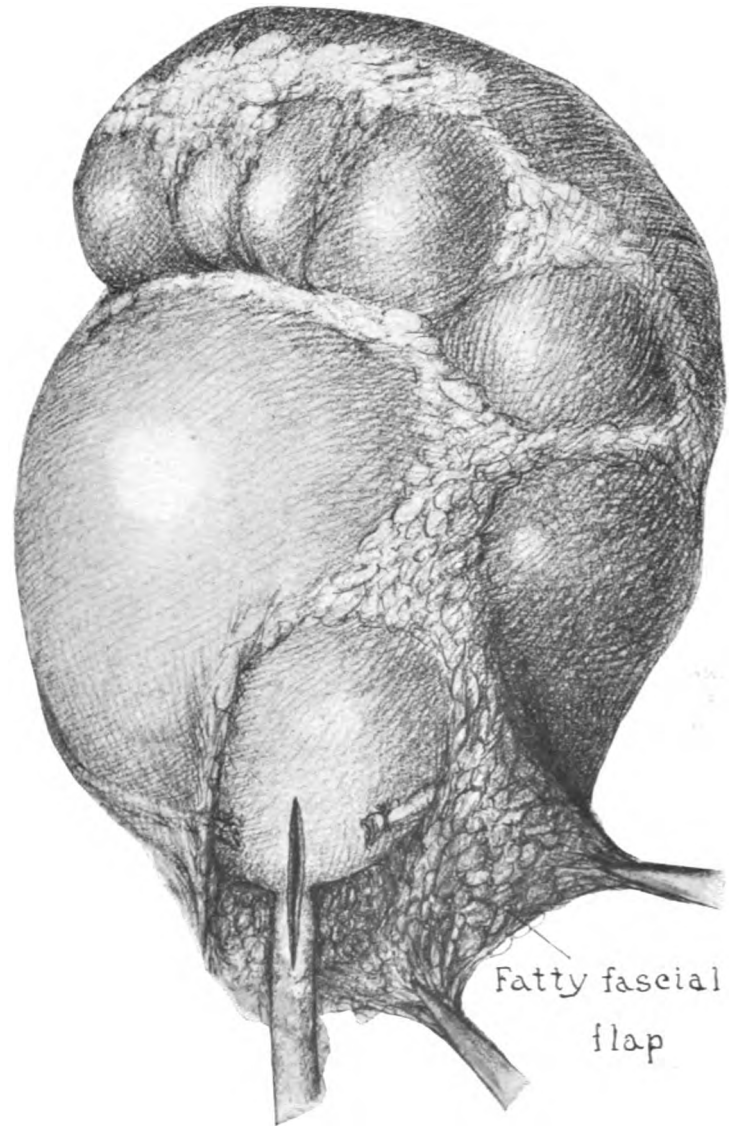
When we find the kidney hopelessly destroyed by infection, or from a malignant growth of the organ, a nephrectomy can be done through the same incision that we use for a nephrotomy. In case a diagnosis of a malignant



HYDRONEPHROSIS FROM KINKING URETER CAUSED BY ANOMALOUS BLOOD VESSELS. (MAYO.)

growth is made before the operation is begun, we prefer the anterior incision along the outer edge of the rectus abdominis muscle. The incision may be prolonged sufficiently to remove a kidney under any condition without the necessity of pulling upon the tissues. In difficult cases the posterior incision is not sufficiently long, even though it be extended from the ribs to the ilium. Aside from the incision the steps of the operation are the same. The kidney is carefully loosened from the fat capsule in non-malignant cases. Then a pair

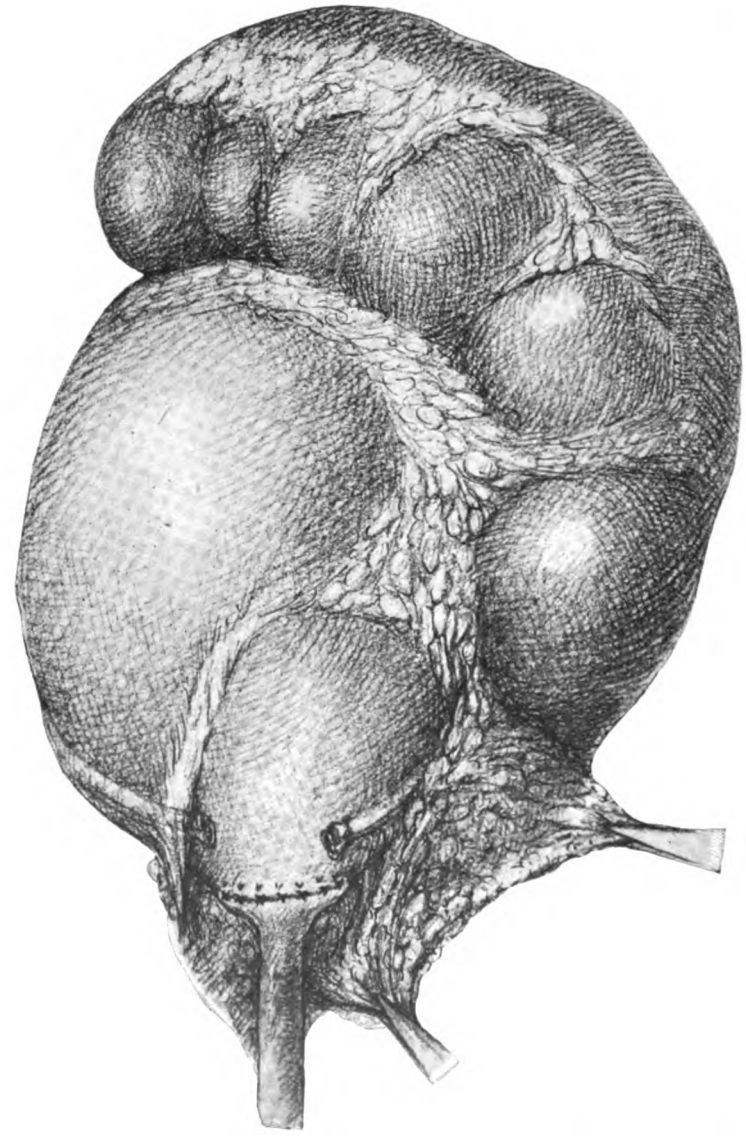
of clamp forceps are applied to the vessels entering the kidney. These forceps should be perfectly reliable, but should not be sharp at any point, in order not to injure the vessels. The renal veins are thin-walled and easily injured,



BLOOD VESSELS CUT AND TIED. FATTY FASCIAL FLAP RAISED AND URETERO-PELVIC JUNCTURE DIVIDED. (MAYO.)

consequently great care should be exercised in loosening the kidney. Dragging upon the renal vessels is dangerous, for the veins might easily be torn. This accident is somewhat more likely in removing the left kidney because of the anatomical peculiarity of the right renal vein. After the forceps have been applied the kidney is cut away by severing the vessels just as they enter the

pelvis. The vessels which project beyond the forceps are now picked up separately, ligated with catgut, then a general ligature of catgut is passed about the entire pedicle. As this ligature is tightened the forceps are loosened so as



PLASTIC OPERATION ON URETERO-PELVIC JUNCTURE COMPLETED. (MAYO.)

to permit the ligature to compress the vessels in the pedicle to the fullest extent. In this way each vessel is ligated twice, which eliminates the danger to the patient from the slipping of a ligature. It is important to apply the ligature slowly and carefully because it may cut the wall of the vein and cause a fatal hemorrhage.

If the kidney is small the ligature may be applied to the vessels composing the pedicle before the kidney has been removed, without first applying the pressure forceps. In other cases in which it seems difficult to ligate the pedicle after the pressure forceps have been applied this may be avoided by simply leaving the forceps in place for twenty-four hours and arranging the dressing around this in a manner to prevent pressure upon the handles of the forceps. These forceps are loosened twenty-four hours after the operation and removed twelve hours later after the stump has withdrawn from the bite of the instrument.

This method has been so much more satisfactory in our practice than ligation of the pedicle that for several years we have used it entirely in a large number of cases, and have never had an unfavorable effect. We use strong but quite elastic forceps, finely serrated, with perfectly smooth ends. We always apply two pairs, then cut the pedicle beyond the second pair, then remove the pair farthest from the kidney and leave the other in place so that the pedicle extends about one cm. beyond the grasp of these forceps.

The wound is sutured down to the forceps. In case the stump has been ligated it is well to leave a wick of iodoform gauze in the wound extending down to the stump, which may be removed in a few days unless during the removal of the kidney the wound has become infected with pus spilled from an abscess. In this event a tubular rubber drain should be added to the gauze tampon.

Both the preparatory and the after-treatment are the same as in those cases in which nephrotomy is performed. It happens occasionally that the other kidney, which was fairly normal before the operation, secretes little or no urine for several days afterwards. This, however, is not so common if elimination has been favored before the operation by the use of milk diet, cathartics and an abundance of distilled water as where this precaution has not been taken.

Relative anuria after operation. Should anuria occur subcutaneous transfusions of a quart of normal salt solution once or twice a day, and the use of saline cathartics and steam baths, and continuous rectal instillation of water by the drop method, are indicated. Some of these patients suffer severely from nausea or vomiting, which is most readily relieved by thoroughly irrigating the stomach, through a siphon stomach tube, with normal salt solution as hot as it can be borne, up to 110° F.

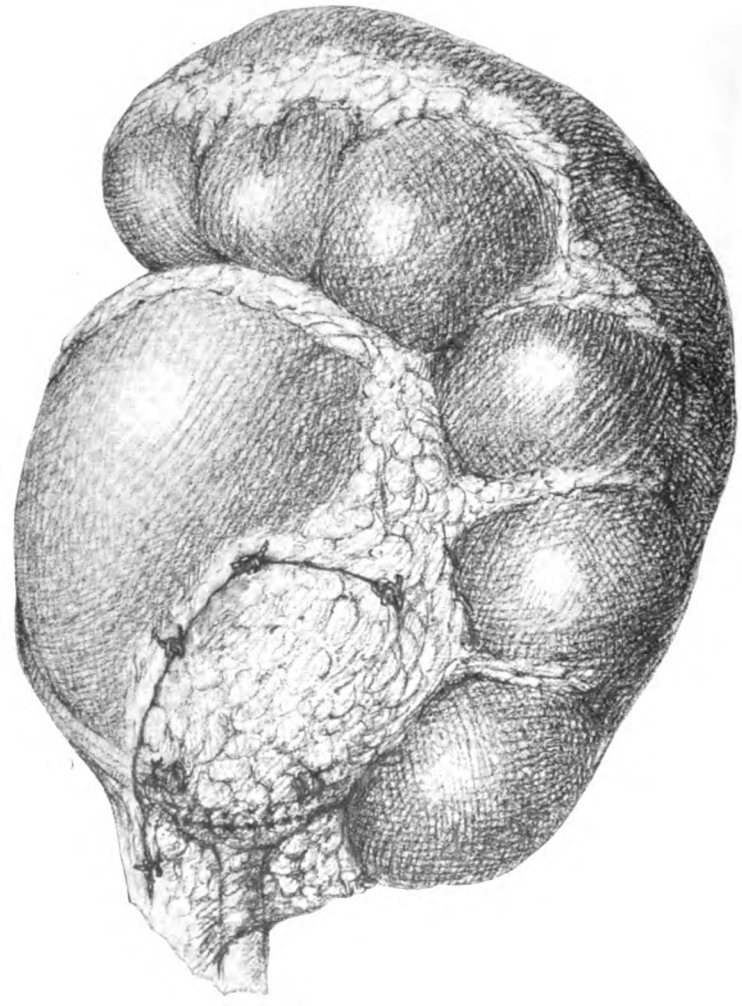
The hot gastric lavage alone is sometimes shortly followed by the free secretion of urine. In other patients the same results may be obtained by giving a warm enema of one-half pint of normal salt solution every hour, introducing the fluid by the drop method.

From internal remedies we have not seen much benefit in such cases, and can consequently not speak of them confidently, with the single exception of freshly prepared infusion of digitalis made from reliable leaves.

An enema of warm salt solution in quantity varying from eight ounces to one pint, to which from ten to twenty-five grains of sodium acetate has been added, frequently increases the flow of urine in these cases in which there is little or no urine excreted for some hours after the operation. This may be administered every hour at first, and less frequently later on.

The value of gastric lavage with hot normal salt solution in cases in which nausea exists is certainly very great, as it removes a quantity of decomposing mucus from the stomach and supplies fluid for the purpose of stimulating diuresis. When given as hot as can be borne and repeated frequently the patient usually begins to perspire freely during the adminis-

tration of the lavage, and this in itself is of course of great benefit. Placing a canvas tent over the bed with the patient's head protruding, and filling this tent with hot air generated from a Bunsen burner, is very beneficial.



FATTY FASCIAL FLAP IN POSITION AND HELD BY A FEW CATGUT SUTURES. (MAYO.)

CYSTIC KIDNEY

Occasionally a kidney containing multiple cysts is encountered. Were these in only one kidney a nephrectomy might be indicated; but as it is usually present in both kidneys at the same time, and as there is consequently not very much kidney substance left, it is not wise to do a nephrectomy in such cases, because the operation is very likely to give the patient no relief, and usually hastens his death. It seems wiser to split the true capsule of the kidney throughout its length, to peel it back on each side, and cut it away, and possibly to make crucial punctures of the superficial cysts. This will relieve the tension upon the remaining kidney tissue, it will improve

the blood-supply to the kidney, and will not reduce the amount of kidney tissue.

This method has, however, not been sufficiently tried to have a position among recognized surgical operations, and we simply mention it here for want of a method we can recommend from personal experience.

If the kidney contains but few cysts these may be excised without difficulty and with safety to the patient, the defect being closed by one or two catgut sutures.

Treatment of congenital cystic kidney. Lund, of Boston, recommends very enthusiastically the treatment suggested by Professor Rovsing, of Copenhagen, according to which one of the kidneys is exposed by a posterior incision. The cysts are laid open and the cavity tamponed with gauze which is left in place for a period of ten days. If possible all of the cysts of the kidney are treated in this way; then the kidney is replaced and drainage instituted. As soon as the patient has regained a normal condition and the wound has completely healed the same procedure is applied on the opposite side. The results from this operation have been very satisfactory.

We would suggest a form of treatment in addition to this which has been most satisfactory in a number of cases under our care. This consists in the administration of only such articles of food as require the least amount of wear and tear upon the tissues of the kidneys for the amount of food value received by the patient. The diet should consist largely of milk, cream, buttermilk, cooked vegetables and cooked fruits. Meat and fresh fish should be given very sparingly. Eggs either soft-boiled, poached or raw serve the same purpose, so far as the nutrition is concerned, as meat, but the wear and tear upon the kidneys is very much less. They can therefore be given in moderate quantity.

NEPHRORRHAPHY FOR THE RELIEF OF MOVABLE KIDNEY

Clinical case. The patient is a married woman, twenty-four years of age, the mother of two children, three and five years of age. She gives the following history: Father died of pulmonary tuberculosis; otherwise the family history is good. The patient's health was good until one year ago, when she took a mis-step and came down very forcibly on one foot. From that time on she suffered from a dragging pain in the right side of her back, just below the last rib. This has increased constantly. In the meantime she has also become very nervous, and has lost her former vigorous appearance. She is unable to do housework without greatly increasing her suffering. She locates her pain in the region of the right kidney. There are no digestive disturbances, no nausea or vomiting, but the patient suffers greatly from gaseous distension of the intestines.

Present condition. The patient is fairly well nourished; her appetite is fair; the bowels are regular. Heart, lungs and urine are normal. The right kidney can be palpated and moved beyond the median line and down opposite the anterior superior spine of the ilium. It can be carried up into its normal position, and when it approaches this point it slips into place very suddenly. When it is out of place the space which it should normally occupy is found vacant upon bimanual palpation.

Diagnosis. The same considerations as regards the differential diagnosis may be applied to this as to the previous case. The only condition with which a movable kidney can be confounded, in a case like the one before us, is a pedunculated hydrops of the gall bladder, or a tongue-shaped projection from the right lobe of the liver, known as Riedel's lobe, or a tumor in a very movable cecum or ascending colon. Once we encountered a carcinoma of the pylorus in an extremely movable stomach which was mistaken for a floating kidney. Occasionally a gall bladder occluded by a gall stone will become distended to the size of the movable mass here found without becoming adherent. The neck of the gall bladder will become stretched and the latter may be movable in every direction. It frequently falls into a space in front

of the left kidney and under the edge of the liver, with the same little jerky motion that one feels in replacing a movable kidney. The thickness of the abdominal wall will make it impossible to observe the fluctuation of the fluid contained in the gall bladder, and it may be quite impossible to make a positive differential diagnosis between these two conditions until the abdomen has been opened. Another condition which is more easily differentiated, but which occasionally causes difficulty, is a tongue-like projection downwards from the right lobe of the liver, known as Riedel's lobe (mentioned above). This may be from six to eight inches in length, or even longer, and consequently its lower end can be dislocated a considerable distance. This mass is, however, continuous with the liver, and it is never quite as movable as the mass in this case, and it is always only its lower end which moves, the upper end being continuous with the liver. In our experience this condition has always occurred in patients with thin abdominal walls in whom a diagnosis could be made after a careful examination. Should it, however, exist in an obese patient, such a definite diagnosis could probably not be made.

In this patient, the empty space which exists when the kidney is displaced is so distinct that there can scarcely be a doubt concerning the diagnosis.

Another test might be used by inflating the colon with gas by means of an air pump attached to a tube inserted into the rectum. The distended colon would pass below the mass if it were a distended gall bladder or a deformed lobe of the liver, while it would pass to the inner side of the mass if it were the kidney. This method, although theoretically of great value, is in practice useful only to confirm a diagnosis. If too much weight is placed upon this method the surgeon is likely to err in his diagnosis.

Etiology. Aside from the traumatic cause, we have here the history of two pregnancies, which is another common cause of movable kidney. In many of these cases, a chronic appendicitis, gastritis, enteritis or gall stones, or all of these, exist at the same time, and it is difficult to say whether or not there is any casual relation between these various conditions or whether their co-existence is merely a coincidence, or, again, whether they are all dependent upon an infection from the alimentary canal.

Many years ago Pawlik directed our attention to the fact that of the patients coming into his gynecological clinic of all women who did the work of laborers in the streets, upon buildings or on the farms and who had borne children, seventy-five per cent. were suffering from this condition, but that of all such there were but a few in whom the amount of disturbance caused by the loose, displaced kidney was sufficient to require treatment. Our own observations have confirmed this in the study of many hard-working, foreign women who came under care for the treatment of other conditions, and in whom the general physical examination revealed the presence of this anomaly. Scarcely one per cent. of all patients in whom the kidney is movable to a markedly abnormal degree require operation. On the other hand, we observe twenty cases in whom nephrorrhaphy has been performed without the slightest benefit, for each case in which the patient has been benefited by the operation.

Indications for operation. In the presence of an anatomical lesion which may be easily removed, to which the patient's suffering is directly referred, and wherein the sudden occurrence apparently initiated the pain, there can scarcely be a doubt regarding the indication for operation. This is especially true in patients who are not otherwise neurotic and who were in good health before the accident occurred which loosened the kidney, and in whose case there is no pending question of liability for personal injury. All of

these matters must be carefully considered, because otherwise the operation must become more and more discredited.

The preparatory treatment should be the same as for ordinary abdominal sections.

Technique. The same incision which has been described in connection with the previous case will be made, the fatty capsule opened, and the kidney brought up for inspection. It is quite normal, aside from the fact that it is so freely movable. The pelvis is not distended and it is evidently free from infection.

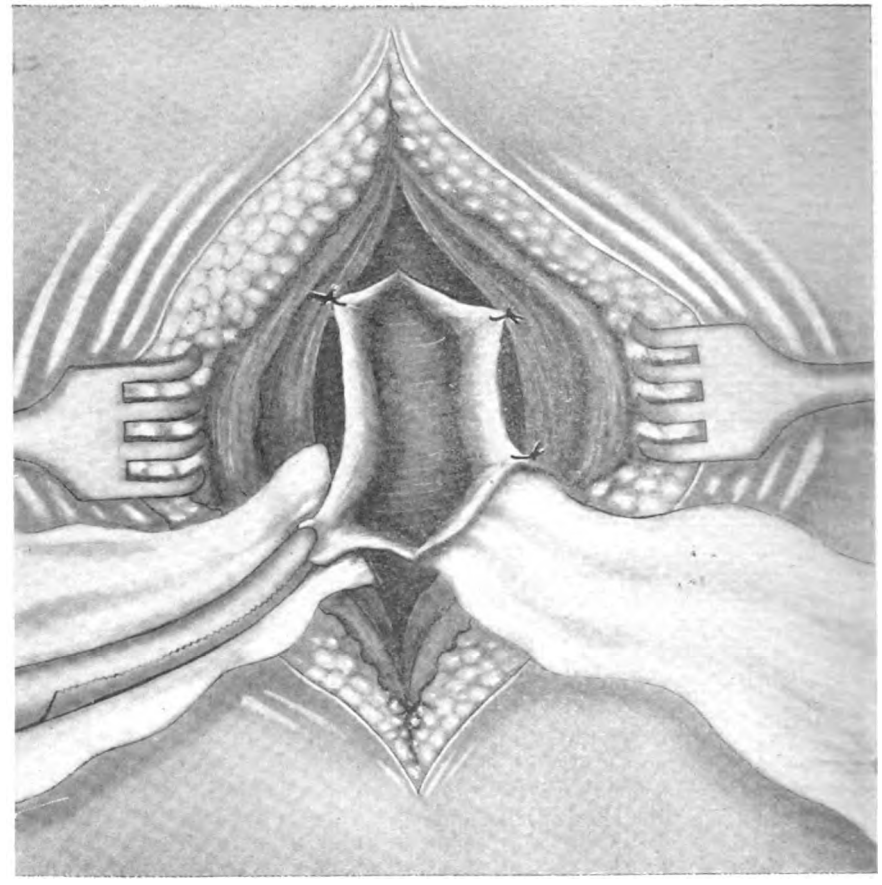
So large a proportion of patients suffering from movable kidney suffer also from chronic appendicitis and gall stones that we usually examine these organs at the same time, provided the kidney is free from infection. This can be done by making a small opening in the peritoneum in front of the colon, inserting one or two fingers and palpating these organs. In this case we find the gall bladder free from disease, but the appendix, which is four inches in length, club-shaped at its distal end and constricted at its cecal end, contains a number of fecal concretions. We will bring the appendix and the lower end of the cecum out through the opening in the peritoneum and remove the former by the method described in the section on appendicitis. The opening in the peritoneum is then sutured with catgut and the operation upon the kidney is proceeded with.

The kidney is first brought out of the wound, as shown in the plate, then its capsule is split longitudinally a distance of two to three inches and loosened from the surface of the kidney a distance of about one inch, as shown. Next a strand of iodoform gauze is passed underneath the lower pole of the kidney, likewise shown in the plate, and fastened to the capsule of the kidney by means of a fine catgut suture on either side. The kidney, together with the attached gauze, is then replaced in the body, as shown in the next plate, and the true capsule of the kidney is sutured to the fascia of the quadratus lumborum muscle by means of a number of chromicized catgut sutures, as indicated. A small strand of iodoform gauze is passed down to the denuded surface of the kidney, and then the entire wound is sutured, with the exception of the space occupied by the strands of iodoform gauze. These are removed about ten days or two weeks after the operation; by which time vigorous granulation tissue will have developed, later forming connective tissue to keep the kidney in place.

Many surgeons do this operation without the use of the gauze and claim equally perfect results, hence this part of the procedure can hardly be considered absolutely necessary. It seems as though, in this case, the removal of the appendix, with its enteroliths, is likely to give the patient quite as much relief as the nephrorrhaphy. This has been borne out by our clinical observations. Patients in whom no lesion is corrected except the movable kidney, rarely make a satisfactory recovery, while quite the contrary is true of those in whom some other important lesion has been found and corrected.

The amount of displacement which we have found in this case might easily have caused an obstruction of the ureter and a consequent hydronephrosis. This may occur as a result of an acute bend or twist in the ureter. In either event simple drainage as practised in the case described will result in the contraction of the dilated pelvis of the kidney, and suspension of the kidney in its normal position, according to the method just outlined, will prevent the obstruction to the ureter in future; consequently a permanent recovery may be expected unless ulceration has resulted from the distortion of the ureter, and this in turn produced cicatricial constriction forming a fibrous stricture. The degree of constriction will determine the form of treatment in such cases. If the constriction is only moderate, simple drainage of the

hydronephrosis, together with nephrorrhaphy, will result in a sufficient degree of relief to promise a complete recovery, because the connective tissue will become softer and the edema reduced, and consequently the passage of the urine through the ureter will become more and more free and presently all of the urine will pass in the natural way. If, however, the constriction is great, nothing less than a nephrectomy will usually suffice to give re-



NEPHRORRHAPHY.

The kidney has been replaced, its lower pole being supported by a strand of iodoform gauze. The loosened capsule has been sutured to the muscles and fascia in the lumbar wound. Usually the number of sutures used in attaching the capsule to the fascia is greater than shown in this figure.

lief. It is, however, to be hoped that in the future plastic operations or resections of the ureter will yield more satisfactory results than at the present time. It is not likely that dilatation with bougies or sounds will ever accomplish much in these cases because of the difficulty one encounters in introducing bougies, the danger of rupturing the thin-walled ureter and the danger of infection. The lack of permanency of results after dilatation of strictures in other tubes in the body, convince us that dilatation of ureteral strictures must be looked upon as visionary in all except the neurotic. In

cases of congenital or acquired deformities causing obstruction the methods already described are indicated.

Billington operation. Billington, of Birmingham, has advised the following operation, for fastening up the kidney, which we have found to be very satisfactory.

A posterior incision is made similar to the one described in the previous operation, except that the incision extends upward to the upper level of the twelfth rib. The kidney is exposed and its fatty capsule removed. A triangular flap of the true capsule of the kidney is loosened from the upper pole downwards, one-third the length of the kidney, a curved forceps is now passed just above the twelfth rib downward into the kidney space. This forcep grasps the free end of the triangular flap of the kidney capsule and draws it up around the twelfth rib, where it is sutured with chromic catgut to the muscles and deep fascia. This brings one-third of the kidney up above the upper border of the twelfth rib. The kidney is then further fastened by placing three chromic catgut sutures through the capsule and a small portion of the kidney substance, and suturing to the lumbar muscles. The rest of the wound is closed in the usual manner without drainage.

Complications of floating kidney. A considerable proportion of patients suffer at the same time from other intra-abdominal diseases. Many of them have at some time suffered from acute appendicitis complicated with peritonitis, followed by extensive abhesions. It seems reasonable to suppose that these adhesions would have a casual relation to the development of floating kidney, either by producing direct traction upon this organ or by necessitating an abnormal amount of intra-abdominal pressure to force the intestinal contents through the intestines in the vicinity of the appendix, and especially through the ileo-cecal valve.

To force the intestinal contents through the ileo-cecal valve the intestine must be fairly well fixed at its mesenteric attachment, as is the case with the small intestine in its normal condition or with the colon when normal. When the enteroptosis obliterates this condition and adds to it the actual obstruction caused by the kinking which results from enteroptosis and adhesions combined, the obstruction may of course be extreme and the effects of all of these complications should not be attributed to the fairly inoffensive loose kidney.

A considerable number of these patients also suffer from gall stones. It is difficult to establish a reasonable casual relation between these two conditions, although such a relation between gall stones and appendicitis is much easier to explain and it is possible that both gall stones and floating kidney in these cases are secondary to appendicitis, although this has by no means been proven. The frequency of these two complications explains the failure in obtaining symptomatic relief in many patients suffering from floating kidney in whom the anatomic result after nephrorrhaphy has been perfect.

PLASTIC OPERATIONS ON THE PELVIS OF THE KIDNEY

The principal conditions requiring plastic operations upon the pelvis of the kidney are strictures of the ureter at its junction with the pelvis of the kidney, closure of the pelvis after removal of stones and the repair of the ureter after its partial or complete detachment from the pelvis during operations upon the kidney. Even with most careful suturing of the pelvis of the kidney one is apt to have a leakage of urine. To overcome this condition W. J. Mayo has devised and put into practice a method of utilizing the fascia which is closely attached to the kidney, especially about the pelvis, as a protection to the suture lines in the part of the kidney.

In plastic operations upon the pelvis of the kidney for intermittent hydronephrosis with a stricture at the juncture of the ureter and the pelvis of the kidney, the operation is as follows: The fatty fascial flap is dissected back as shown in plate. A longitudinal incision is made through the ureteropelvic juncture; this incision is now sutured transversely with fine catgut after the method of a Heinicke-Mikulicz pyloroplasty (see plate); the fatty fascial flap which was reflected in the early part of the operation is now sutured back in place, covering over the line of suture uniting the pelvis and the ureter. Even though it can be seen that at some points the suture in the pelvis is not urine tight, yet after the fatty fascia flap is sutured over this area, primary union will usually take place without any leakage of urine.

In operating for stones in the pelvis of the kidney in patients whose kidneys are not infected enough to require drainage, the incision in the pelvis can be closed without any leakage of urine. In cases of stone in the pelvis it will usually be found that there is an increase in the fatty tissue in the region of the pelvis, which is also adherent thereto. In these cases the incision is made directly through the fatty tissue and the pelvis as though they were one.

After the stone is removed, the incision in the pelvis and in the fascia covering are sutured as a part of each other, with a row of fine catgut. If the opening in the pelvis has not been injured during the removal of the stones, this one row of sutures will usually be sufficient to prevent leakage. If the opening in the pelvis has been torn during the removal of the stones, making an irregular edge, the opening is first sutured as above, and then a flap of the fatty fascia can be made and turned back to protect the line of suture. This flap does not need to be sutured tightly, but two or three catgut stitches are placed in such a manner as to keep the parts in apposition. A cigarette drain should be carried down to the vicinity of the suture line and left in the wound.

DECAPSULIZATION OF THE KIDNEY FOR CHRONIC NEPHRITIS

While speaking upon this subject it seems proper to describe a relatively recent operation upon the kidney which has not as yet earned a position among recognized operations, but which seems to be based upon reasonable principles. We refer to the operation of removing the true capsule of the kidney for the cure of chronic nephritis.

The same incision is made as in nephrorrhaphy; the capsule is split in the same manner but throughout the entire convex surface of the kidney. It is then carefully stripped down on either side and cut away, leaving the entire surface of the kidney in contact with the surrounding tissues. It seems that new blood vessels form in great numbers and that the remnants of kidney tissue which have not yet been destroyed by the disease will suffice to carry on the function of the organ to a very marked extent after this operation.

As we have stated above, however, this procedure has not as yet passed through a sufficient period of observation to be established as a recognized operation. Since the above was written a few years ago the method has been much lauded by some authors and thoroughly condemned by others. The prevailing opinion at the present time seems to be that in cases in which the nephritis is due to obstruction of the circulation caused by malposition of the kidney this operation, combined with nephrorrhaphy, may be of benefit. It is certain that in such cases albuminuria will disappear.

The number of these cases is so small, however, that it is not of very great importance. In connection with Dr. George Suker we were able to

demonstrate that in no case in which there existed an albuminuric retinitis at the time of operation was any permanent improvement obtained.

RESECTION OF THE KIDNEY

This operation is but rarely indicated, as the reason for which one would be likely to perform it is the removal of tumors. The kidney is so seldom the seat of benign tumors that this condition scarcely deserves consideration, the small benign cyst having been mentioned before. In malignant disease of the

RENAL CALCULUS FILLING ENTIRE CAVITY OF RENAL PELVIS, REMOVED THROUGH PYELOTOMY.

kidney even the complete removal of the organ promises but little; hence a resection would almost certainly be followed by a rapid recurrence. In severe crushing injuries a resection sometimes becomes necessary. In these cases the extent of the excision will depend upon the degree of the trauma. It should be in the form of a wedge-shaped piece in order to permit of the closure of the defect.

Sutures are likely to cut through the kidney tissue if applied directly, but if passed through gauze folded upon itself from two to four times, then through both edges of the wound, then again through layers of gauze, then

back in the opposite direction, they can be tied without cutting. These sutures should be of catgut which will last about ten days before being absorbed. The strips of gauze may be permitted to project from the wound so as to be withdrawn when they are freed by the absorption of the catgut sutures.

The same plan may be employed after nephrotomy if the hemorrhage is so severe that it cannot be controlled by tamponing. If drainage of the pelvis of the kidney is desired, in a case in which this plan is indicated because of severe hemorrhage, one or two rubber drains may be wrapped in iodoform gauze and inserted into the pelvis of the kidney, and then the sutures applied as before, the cut edges of the kidney being thus pressed against the gauze surrounding the rubber drains.

RENAL CALCULUS

Since the development of radiography it is a rather rare case in which a positive or negative diagnosis of stone in the kidney or ureter cannot be made. In a very good plate, except occasionally in very fleshy people, the outline of the kidney, as well as the stone, should be shown. It should not be forgotten that kidney stones are frequently bilateral and that a photograph of both kidneys should be taken whenever a renal calculus is suspected.

The treatment of renal calculus is surgical and should be undertaken as soon as the diagnosis is made and it is evident that the stone cannot be passed. Small stones will frequently pass after the administration of large quantities of distilled water accompanied by large doses of glycerine.

When the stone is in the ureter and is small, an effort may be made to dislodge it by distending the ureter with glycerine through a ureteral catheter.

Or, if it be low down or lodged at the ureteral orifice, it may be grasped with a pair of forceps and removed through a cystoscope, as described under the heading of cystoscopy.

Pyelotomy. In case a stone is located in the pelvis of the kidney the diameter of which does not exceed two or three cm., it can usually be removed by splitting the pelvis posteriorly in the direction of the ureter. This should of course not be done if the stone is very large, with sharp projections extending into the calices, because in such case the injury caused is much greater than it would be after splitting the kidney longitudinally. The finger should be inserted into the kidney pelvis through the opening and a careful search made for further separate stones. The stone removed should be examined to determine whether any fragment has been broken off in its extraction. The wound should be drained by a fine, soft, split, rubber drainage tube, and a few cigarette drains should be passed down to the kidney pelvis to drain the surrounding loose tissue.

In all of these cases the patient should permanently drink only distilled water, or spring water which is practically free from any mineral substances, because in this way recurrence may be prevented.

EXCISION OF THE URETER

If the ureter is diseased in connection with the kidney, which is not uncommon in tuberculosis, it may be excised by following it from above downward. If disease of the ureter is diagnosed before the operation is begun it is better to make an oblique incision so as to carry the lower end thereof to a point near the anterior superior spine of the ilium, provided the posterior incision has been chosen. If the anterior incision has been selected it is well to split the outer edge of the rectus abdominis muscle

longitudinally. This incision may be lengthened to suit the convenience of the operator. When the bladder is reached the ureter is cut off and a small, purse-string suture applied to cover the stump. The wound is then closed with two or three rows of catgut sutures, unless infection has taken place from an ulcerated ureter or from pus in the pelvis of the kidney, in which event the wound should be drained with iodoform gauze above and below and the intervening portion sutured in order to prevent the formation of a hernia.

After the kidney and the ureter have been removed the suppuration will subside rapidly, even if it has not been possible to effect the removal without spilling some of the pus contained.

Exposing the ureter. Dr. John M. Binnie has described a simple method of exposing the pelvic portion of the ureter.

With the patient in the Trendelenburg position a median incision is made beginning close to the pubic bone and extending upward, exposing the space of Retzius in the usual manner. No muscle fibres are cut but the recti are retracted to either side. The point where the paretial peritoneum is reflected onto the bladder is noted and care taken not to open the peritoneal cavity. Starting at the bladder the peritoneum is wiped away toward the median line separating it from the bladder and pelvic wall, thus exposing the ureter. With retraction one gets a complete exposure of the ureter and any necessary procedures may be carried out under the guidance of the eye. Drainage, if necessary, may be instituted through the original incision or through a separate stab wound.

CALCULUS IN THE URETER

The symptoms in this condition at the time the patient comes under the care of the surgeon usually simply consist of localized pain, but there is always a history of renal colic preceding the complaint.

The pain may be at any point in the course of the ureter, although the calculus is practically always located at one of three points, viz., (1) at the beginning of the ureter, (2) at a point where the ureter passes over the edge of the iliacus muscle, and (3) just before the ureter empties into the bladder.

The stone may almost always be located with the X-ray, provided the intestinal tract has been thoroughly emptied by the use of castor oil and enemata, and of course provided that the apparatus and technique employed are good. Occasionally a fecal concretion in the appendix may be mistaken for a renal calculus in the skiagram, and at times a calcareous phlebolith has been so mistaken. Of course if the colon has not been properly emptied hardened fecal masses may cause a shadow which will be mistaken for a calculus. Then again, at times a renal calculus may be so transparent that it will not cause a sufficient shadow to be recognized on the plate.

Ordinarily, however, this method of diagnosis is eminently satisfactory, especially if a shadow-casting catheter has been passed in the ureter before the radiograph has been taken. In this way the relative positions of stone and ureter can be determined.

Treatment. An abdominal incision is made directly over the seat of the stone, according to the plan for abdominal incisions as indicated heretofore. The peritoneum is split longitudinally over the ureter, then the latter is lifted into view and the surrounding area tamponed away with moist gauze pads, then a longitudinal incision is made once and a half the length of the diameter of the stone and directly over the most prominent portion thereof, in order that the stone may be removed without crushing or tearing the wall of the ureter. The stone is then lifted out and the edges of the wall of the ureter

permitted to fall together. A rubber drainage tube with a notch cut out of its lower end is now placed down upon the ureter at the point of the opening and held in position by a fine catgut suture, then this tube is surrounded by four or five cigarette drains which are all permitted to pass out of the abdominal wound with the rubber tube.

Should the ureter be enlarged above the point at which the stone was located the rubber tube is carried into the lumen of the ureter, but if there has been no obstruction this is not necessary.

SECTION OF THE URETER

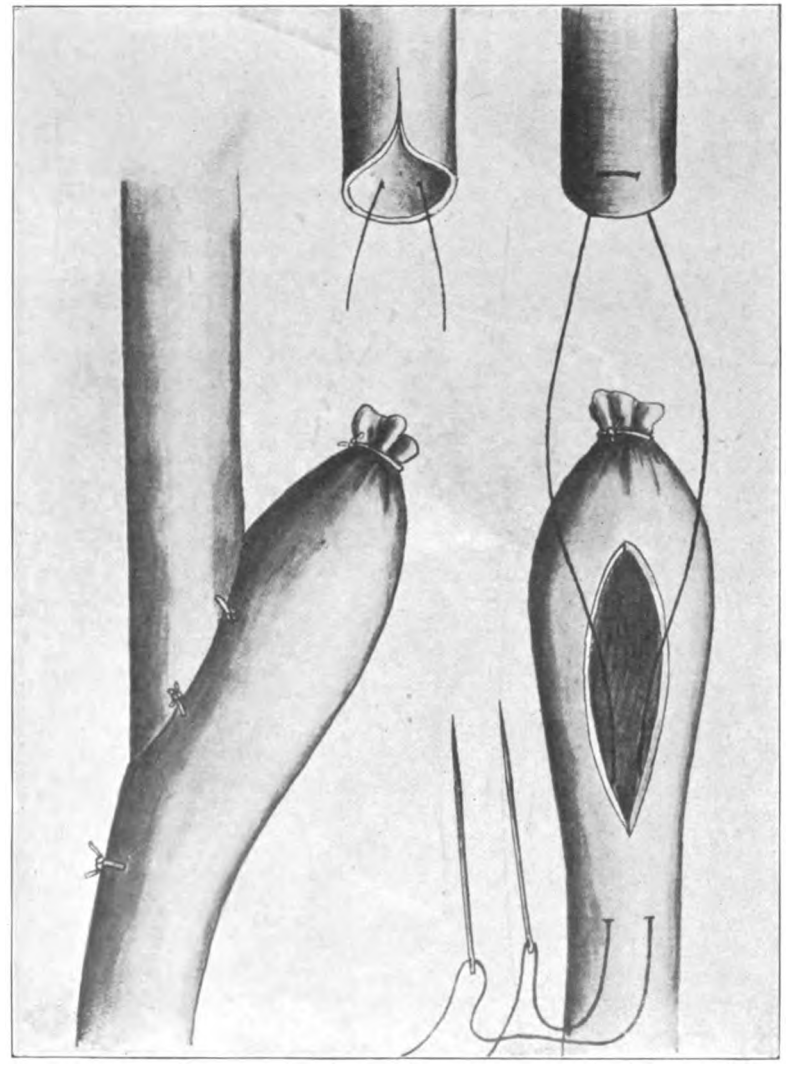
Van Hook operation. If the ureter is cut during an operation, except in cases in which this is done for the removal of a malignant growth, an attempt should be made to repair the damage immediately. If the section is at any point more than a few cm. distant from the bladder it is best to telescope the upper segment either directly into the lower segment or through a lateral incision, according to the method introduced by Van Hook. This operation consists in passing a probe into the upper end of the lower segment and cutting down upon this probe one and one-half cm. lower down, making a lateral slit 5 mm. in length, then ligating the upper end of the lower segment, then a fine silk suture is passed through one edge of the lower open end of the upper segment, then both threads are threaded in one needle which is passed up the lumen of the lower segment through the lateral slit and out through the opposite wall one cm. beyond the distal end of the lateral slit. Thus the lower end of the upper segment is telescoped into the lumen of the lower segment through the lateral slit. The edges of the slit are carefully sutured to the side of the upper segment as shown in the plate.

In case the section has occurred within a few cm. of the bladder the ureter is laid bare and loosened for a distance of two cm., then a convenient point is chosen in the wall of the bladder and after making a slit in the peritoneal covering the bladder wall is tunneled obliquely with a trocar. The end of the ureter is then split in halves at its distal end and each half transfixed with a fine silk suture both ends of which are then threaded upon a needle. These needles are passed through the opening made by the trocar separately and then the wall of the bladder is transfixed one cm. to each side of the trocar opening, as shown.

In order to make the next step possible a sound is passed into the bladder and its end is engaged in the open end of the canula of the trocar which is in the bladder, and as the canula of the trocar is withdrawn the end of the sound is passed out through the wall of the bladder. The open end of the ureter is then threaded upon this end of the sound and as the latter is again drawn into the bladder the end of the ureter is slipped in with it, when the two threads are drawn taut and tied. The bladder wall is sutured with a few very fine catgut stitches to the side of the ureter and the peritoneum is closed over all. A retention catheter is inserted and the patient is given half a pint of distilled water with five drops of dilute aromatic sulphuric acid every two hours.

A soft rubber drainage tube and several cigarette drains are passed down to the point of anastomosis and out of the lower angle of the wound. These are left in place four days unless leakage occurs, in which event they are left ten days, unless the leakage subsides sooner. The catheter is left in place ten days, being removed for two hours twice each day, in the male, after the second day. In the female a Jacob's retention catheter is used which need

not be removed for ten days unless phosphates accumulate in its lumen, which has never been the case in patients who received the aromatic sulphuric acid and distilled water, as indicated above, although formerly we had much annoyance from this source.



Anastomosis of the Ureter by Van Hook's Method.

PERMANENT URETERAL FISTULA

In cases in which a large portion of the lower end of the ureter, either on one or on both sides, has been destroyed intentionally or accidentally, it may seem wise to preserve the kidney although if the fellow kidney is normal this is usually not necessary, as the patient loses more from discomfort and the danger of infection than he gains from possessing the additional kidney. But if the other kidney is not normal, or if the lower portions of both ureters

have been removed, as is commonly the case in excision of the bladder for carcinoma, then it is proper to provide for a comfortable ureteral fistula.

For a time it seemed as though this could be accomplished by transplanting the ureter into the sigmoid flexure of the colon, but all of the patients died of ascending infection until recently when animal experiments seem to have shown that by transplanting the ureter into the sigmoid by passing obliquely through the wall and then between the muscular and mucous layer for a distance, and then permitting the end of the ureter to project for a distance of one cm. beyond the mucous membrane into the lumen of the intestine, this accident may be avoided. Such a plan of operation looks reasonable and has proven satisfactory experimentally.

As most of these patients die from a recurrence of their original carcinoma within a few years, it seems as though they were entitled to the comfort which this operation offers.

We have not had an opportunity to test this method above mentioned and none of the cases in which it has been employed have been operated long enough to represent a test, hence we must be satisfied for the present with the statement as given.

Watson's device. Watson invented a device for collecting urine from ureteral fistulæ located in the lumbar region which works well.

The ureter is simply passed through the edge of the quadratus lumborum and the latissimus dorsi muscles and permitted to project five mm. beyond the skin where it is attached with fine silk sutures. Watson's device consists of a box with a drainage opening and spout to which a rubber tube is attached and which carries the urine into a rubber bag. The rim of the box is fitted with a pneumatic tube which adjusts perfectly against the patient's back. The box is held tightly in place by a broad elastic belt encircling the patient's body. The pneumatic edge of the box protects the patient against harm from pressure and secures his comfort. By placing a few drops of formalin in this receptacle, and having two of these so that they may be worn on alternate days, they will not become offensive. This method is much safer than the other, and in patients not operated for malignant growths it seems better to employ this plan until the latter class of cases has definitely demonstrated the safety of the oblique implantation of the ureters into the sigmoid.

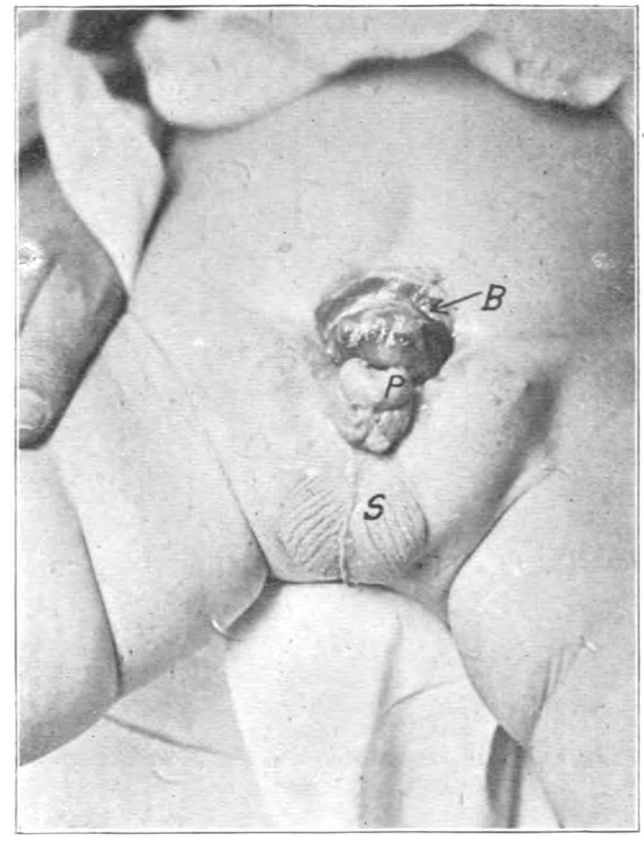
Of the various methods which have been recommended that described above seems to promise the greatest safety.

EXSTROPHY OF THE BLADDER

The condition of exstrophy of the bladder is so distressing that we describe an operation which promises to become generally adopted, although our personal experience is still too limited to warrant recommending it on that ground alone. The entire number of cases which have been operated by this method is also quite small, and in many of them the ultimate result has not been reported, but all the operations which were in use before the introduction of this one can be applied in only a small number of patients and do not promise very satisfactory results at best, while this procedure seems so far to be most satisfactory.

Since the above was written we have performed the operation six times with five recoveries, one patient having died from peritonitis. Another patient died two years later from strangulated hernia, two are still well and two others have not been heard from and the sixth case died from nephritis. The physician caring for the patient considered it a case of septic nephritis due to ascending infection. The death occurred after an illness of a few weeks and after the patient had been well for five years following operation.

Preparation for operation. Two days before the operation the patient is given two ounces of castor oil, in order to remove as much of the mucus and other contents of the alimentary canal as possible with slight irritation. From this time on until the operation is performed, the patient is given only concentrated sterilized food, so as to leave the alimentary canal in as nearly an aseptic condition as can be. No enema is given until the patient is anesthetized; then the rectum and colon are very thoroughly irrigated with boric acid solution, and after the water returns perfectly clear the sphincter ani muscles are

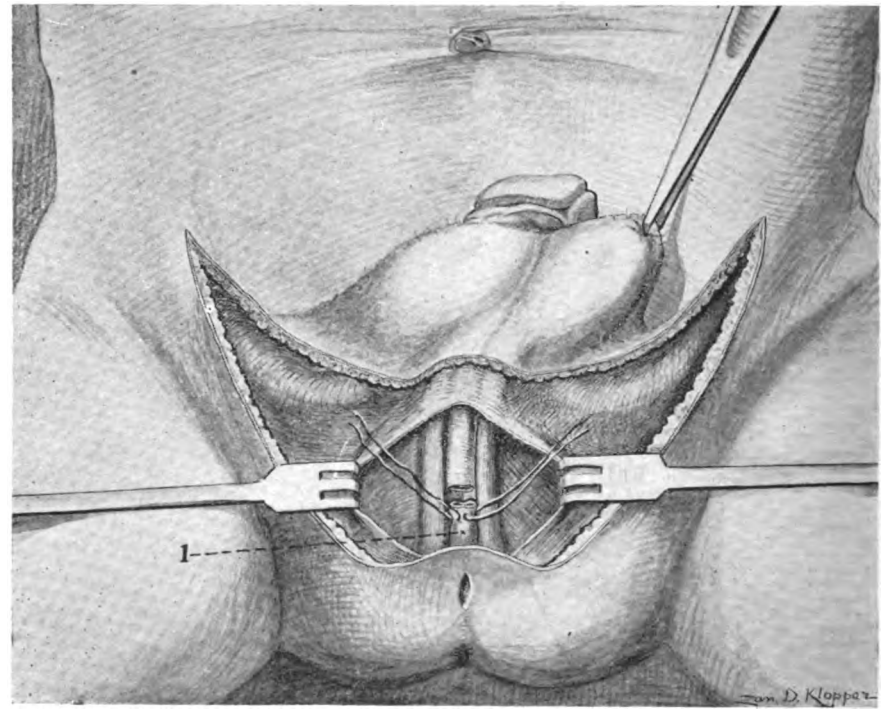


EXSTROPHY OF THE BLADDER. "B" EXSTROPHY, "S" SCROTUM, "P" HEAD OF PENIS.

stretched gently, but very thoroughly. Then the rectum is once more thoroughly irrigated. The patient is placed in the Trendelenburg position and the bladder is carefully disinfected.

Mydl's operation. The bladder is loosened from the abdominal wall throughout the entire distance, two fine probes are inserted into the ureters, great care being taken not to disturb the little valve-like openings at the end of the ureters. Then an elliptical portion of the bladder wall, from two to three centimeters in diameter, is excised in such a manner that the openings of the ureters are as near the middle of this portion as possible. Care must be taken in this step of the operation not to injure the ureters. It is best to begin the incision below and then lift up the portion of the bladder and to observe the direction in which the probes extend into the ureters. In this manner injury to the latter is readily avoided. The segment of the bladder, together

with the ureters, is now held upwards, the urine which issues from the ureters is sponged gently, and the remaining portion of the bladder is rapidly dissected away. Then the sigmoid flexure is brought up into the wound and a longitudinal incision made through the middle of the longitudinal muscular band, two centimeters in length. The segment of the bladder is inserted into the colon and held in place with four silk stitches, two at the end of the longitudinal incision in the colon and one in each edge of the incision half way between these two stitches. Four sutures are previously placed in the wall of the colon, one on each side of the middle of the incision and one just beyond the end of the incision, to be utilized for the purpose of manipulating the intestine



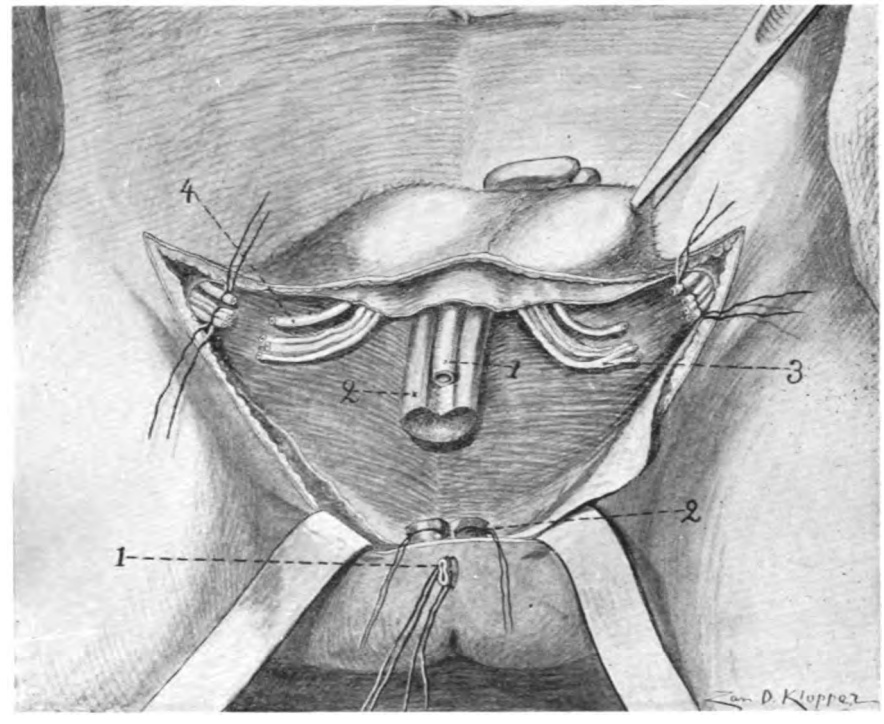
REMOVAL OF PENIS AND SCROTUM FOR CARCINOMA.

With excision of inguinal lymphatics and transplantation of stump of urethra into perineum, showing primary incision.

while the segment of the bladder is sutured in place. The first row of sutures is passed through the entire thickness of the bladder and through the entire thickness of the intestine, care being taken to repeat about the fourth stitch in the continuous suture in order to prevent slipping—after the manner described in the section on intestinal surgery. After the entire segment of the bladder has been sutured into this opening, with the mucous membrane facing the lumen of the intestine, a second row of sutures is applied which penetrates neither the portion of the bladder nor the intestine, but simply grasps a sufficient amount of tissue to bring the serous surfaces carefully and thoroughly in apposition throughout the entire course. The intestine is then dropped into the abdominal cavity. Care must then be taken to isolate the layers of the abdominal wall because the latter is bound to be defective in these cases, and if this precaution is not taken a ventral hernia is very likely to result. This

condition later resulted in the formation of a strangulated hernia in one of our cases which eventuated in the death of the patient. After these layers have been carefully isolated the abdominal wall is closed in the manner described in the section on abdominal surgery.

It is of great importance in these cases to strap the wound thoroughly with rubber adhesive straps, in order to remove the tension as much as possible from the stitches in the abdominal wound. It is also important to administer for the first two weeks after the operation only such food as will give rise to the formation of as little gas as possible, in order to reduce the strain upon the stitches of the abdominal wound to a minimum. The stretching of the



COMPLETE EXCISION OF MALE GENITALIA FOR CARCINOMA OF PENIS.

1, urethra; 2, vascular portion of penis; 3, vessels of cord; 4, vas deferens. Showing urethral stump transplanted into perineum through buttonhole, the end projecting 5 mm.

sphincter ani muscle in the beginning of the operation will aid in preventing accumulation of gas and will reduce the pressure upon the wound in the intestine. Should, however, the sphincter contract sooner than desirable a rectal tube should be inserted and kept freely open, in order to prevent the accumulation of flatus in the rectum.

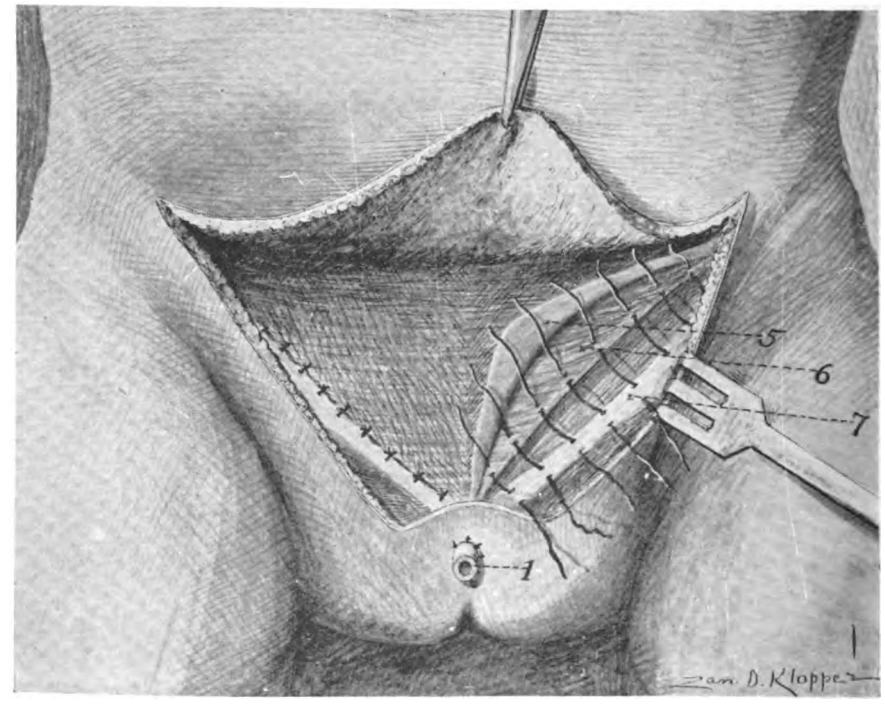
These patients are very comfortable after the operation. They are able to remain perfectly dry, sleep all night and evacuate the urine from the rectum as often as they would normally evacuate the bladder. They are no longer offensive to themselves or their friends and neighbors and they and their families look upon the operation as a great blessing.

It is important not to injure the ostium of the ureter, and for this reason

the probes which are used for marking the location of the ostium and of the ureter during the operation should be manipulated with great gentleness. It is undoubtedly bad practice to leave ureteral catheters in place for several days after the operation, as recommended by some surgeons, because this would surely injure the delicate valve-like openings.

Were it not for these delicate structures it seems unlikely that the operation could have proved satisfactory, although the oblique submucous implantation of the ureters may prove to be satisfactory in time.

Garre's operation for exstrophy. Professor Garre, of Bohn, utilizes the cecum as a bladder in cases of exstrophy.

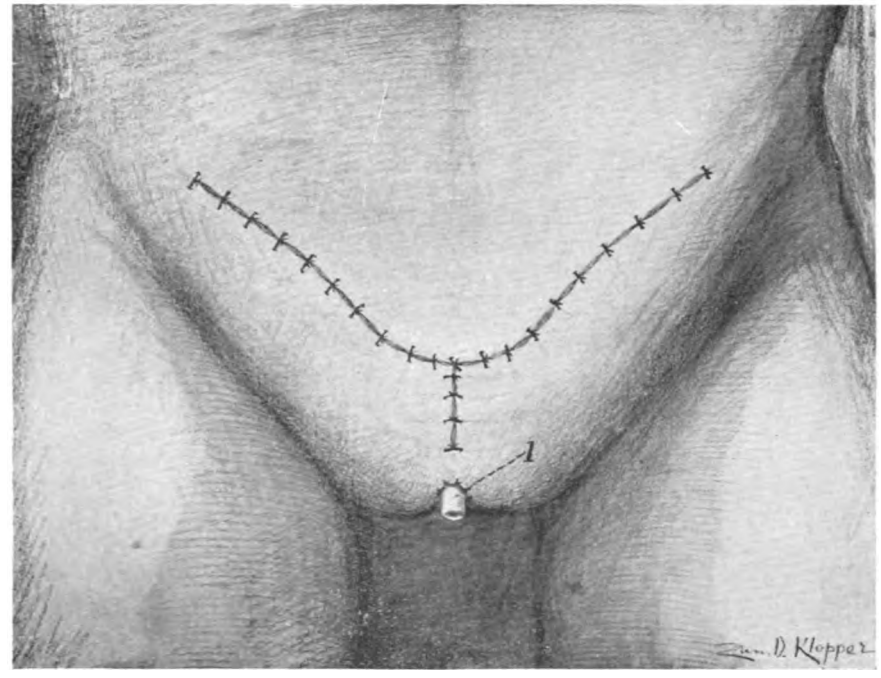


COMPLETE EXCISION OF MALE GENITALIA.

Together with inguinal lymphatics and with transplantation of stump of urethra into perineum through buttonhole in skin. 1, urethra; 5, fascia of internal oblique abdominal muscle; 6, internal oblique abdominal muscle; 7, Poupart's ligament.

The operation is performed in two stages. First an abdominal section is made and the ileum is cut off about four inches from the ileo-cecal valve. The distal end is closed with a purse-string stitch, over which is placed an interrupted Lembert stitch. The ascending colon is cut off about four inches from the head of the cecum and both ends closed with interrupted silk sutures. The proximal end of the ileum is now implanted into the ascending or transverse colon. An appendicostomy is now made and a retention catheter placed through the appendix into the cecum. This completes the first stage of the operation and the abdomen is closed in the usual manner. The cecum is thoroughly irrigated daily with some mild antiseptic solution for a period of four to six weeks. The abdomen is now opened again and the second step of the operation is completed by transplanting the ureters, together with a small por

tion of the bladder around each ureteral opening into the ileum, the end of which was closed at the primary operation. The rest of the mucous membrane of the bladder is dissected out and the defect in the abdominal wall closed as thoroughly as is possible. The retention catheter is kept in place through the appendix for a couple of weeks. After this the urine is allowed to collect in the cecum and is withdrawn with an ordinary catheter about three times daily. The urine does not leak through the appendicostomy opening.



COMPLETE EXCISION OF MALE GENITALIA FOR CARCINOMA OF PENIS.

Together with excision of lymphatics of inguinal region and transplantation of stump of urethra into perineum through buttonhole in skin. Operation completed.

PLASTIC OPERATIONS FOR CLOSING THE EXSTROPHY

In performing a plastic operation for the purpose of closing an exstrophy of the bladder everything depends upon the amount of tissue that is lacking and the portions involved. Each operation must be planned with a view to the formation of a bladder lined with mucous membrane, that will hold the urine or that will serve to direct the flow of urine into a rubber urinal. If possible a urethra should also be constructed. Usually several operations are required and then the results are as a rule only slightly satisfactory.

Of the plastic operations we have obtained the most satisfactory result in a case in which we utilized the mucous membrane of the trough-like urethra in a hypospadias for the construction of a new urethra which we passed out through a large trocar puncture in the perineum. We then made an incision between the mucous lining of the bladder and the skin and then closed the defect by bending the pieces upward and suturing into this defect. A retention catheter was placed into the bladder through the new urethra and aro-

matic sulphuric acid in distilled water was given every two hours. The patient made a very satisfactory recovery.

The boy was only six years old and the operation was performed but three years ago. How the organ will functionate later in life is of course of much interest.

AMPUTATION OF THE PENIS

This operation is done only for the relief of malignant growths which, in our experience, have always been carcinomatous in nature, although there is no reason why other forms of malignant growth should not occur in this organ.

If the disease is confined to the distal end, it may be so circumscribed as to be completely removable by the amputation of only a portion of the organ, but if any doubt exists it is much safer for the patient to make the complete amputation at once, together with a thorough removal of the inguinal lymphatic glands.

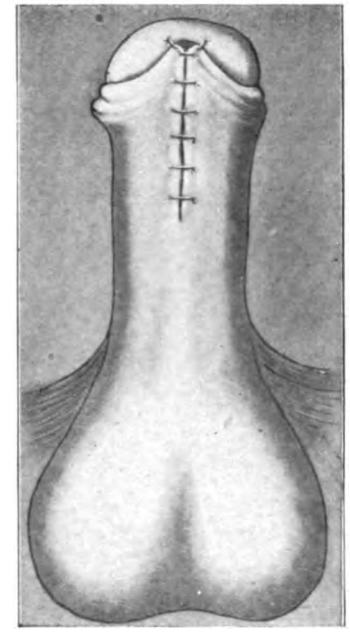
If the condition present seems to warrant the removal of only a portion of the organ, the following method should be employed:

A small rubber tube is stretched and passed several times around the penis near its pubic attachment and then tied, in order to make the operation bloodless. A point is then chosen sufficiently far from the tumor to insure freedom from invasion. Usually this distance should be at least five centimeters; and the greater the distance the better, as these growths are exceedingly prone to recur in this region. After the point for amputation has been chosen the skin is divided with a circular incision two centimeters nearer the pubis. Then a sound is introduced into the urethra and a catgut suture is passed around each corpus cavernosum, and another around the corpus spongiosum down to, but not through, the urethra, which may be determined by the presence of the sound in the canal. These ligatures are carefully tied. Then a circular incision is carried down to, but not through, the urethra, one centimeter away from the point at which the ligatures have been applied, in a distal direction. Then the tissues are stripped from the urethra for a distance of one centimeter in the distal direction, and then the urethra is severed.

The dorsal artery is now caught separately with hemostatic forceps and ligated. Then the elastic constrictor is removed and the stump will be found entirely free from hemorrhage. The projecting portion of the urethra is then split laterally, and carried through a buttonhole in the anterior skin flap, where it is sutured in place with horse-hair sutures. The skin is then drawn over the stump of the penis, and a tenaculum is applied on each side, thus forming a transverse wound. The edges of the skin are united and a complete covering of the stump is formed in this manner. The arrangement of the flaps at the end of the urethra will prevent the contraction of the canal at this point.

This operation leaves the patient in a very comfortable condition, but unfortunately these sufferers do not come under the care of the surgeon early enough, as a rule, to make the procedure justifiable. Unless the case is absolutely incipient we never advise this operation, because it is almost always followed by recurrences, and unfortunately in the recurrent cases the disease has often advanced so far that complete excision is no longer possible, while if the extensive operation described below is done fairly early the relief is very likely to be permanent.

Radical operation. Fortunately the more complete operation gives satisfactory results, both as regards permanency of cure and function of the urethra, even in advanced cases. This operation is, however, much more extensive and correspondingly more severe as regards the production of shock. It contemplates the removal of the entire organ, together with the scrotum, with

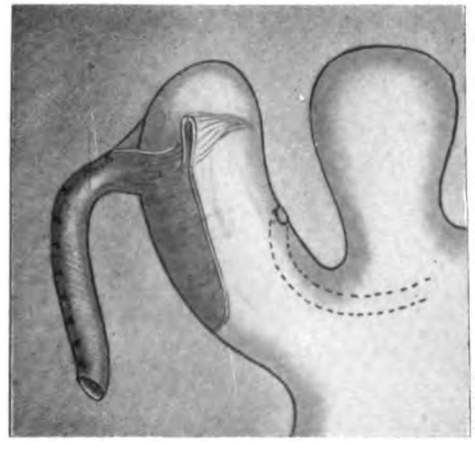


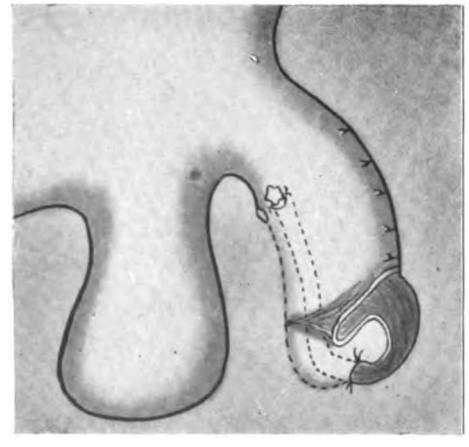
I HYPOSPADIAS OPERATION. II

Fig. I represents the flaps of the foreskin reflected; the urethra carefully dissected free; a perforation has been made through the glans by means of a trocar; the end of the urethra has been caught with fine pointed hæmostatic forceps and carried forward through the opening in the glans.

Fig. II represents the flaps sutured in place, making an artificial frenulum, the end of the urethra having previously been sutured in position a little above the center of the glans.

Taken from Dr. C. H. Mayo's original drawings.



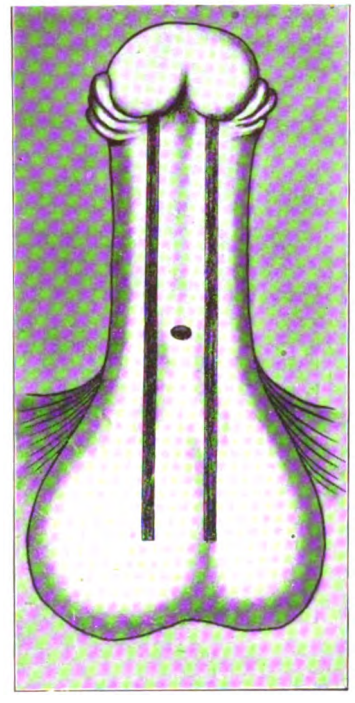


III HYPOSPADIAS. IV

Fig. III represents the prepuce and a portion of the skin from the dorsal surface of the penis dissected up and formed into a canal, with the cuticle turned in for a lining. The urethra is indicated by dotted lines. It opens on the inferior surface of the penis.

Fig. IV represents the glans and the penis tunneled and the newly formed urethra drawn through the defect upon the dorsal surface of the penis closed with sutures.

Taken from Dr. C. H. Mayo's original drawings.



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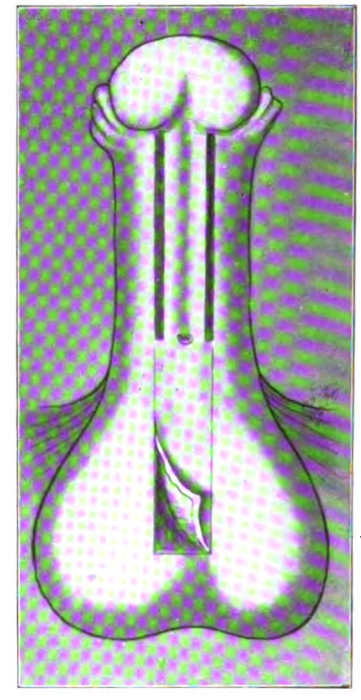
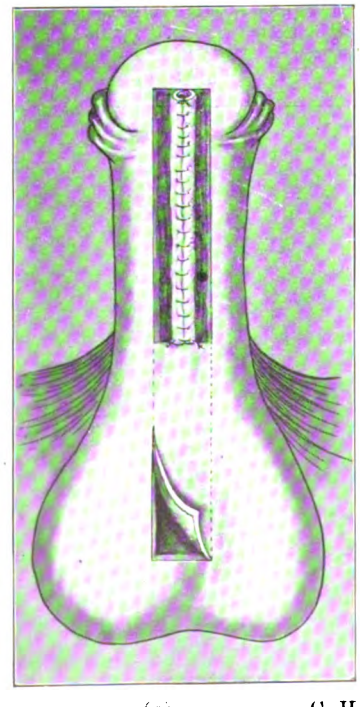


C. H. Mayo method. (b)



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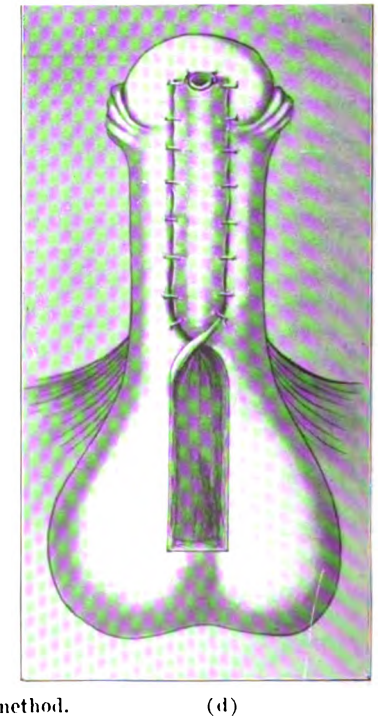
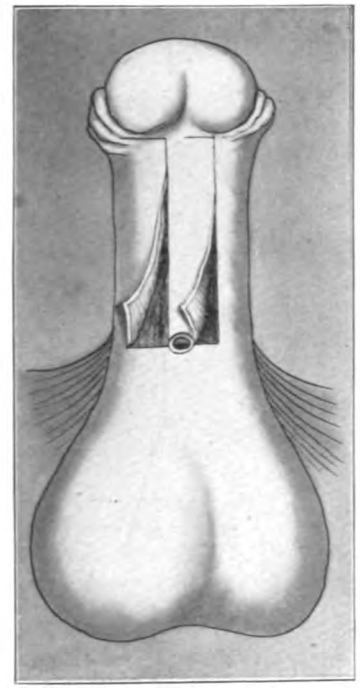


C. H. Mayo method. (d)



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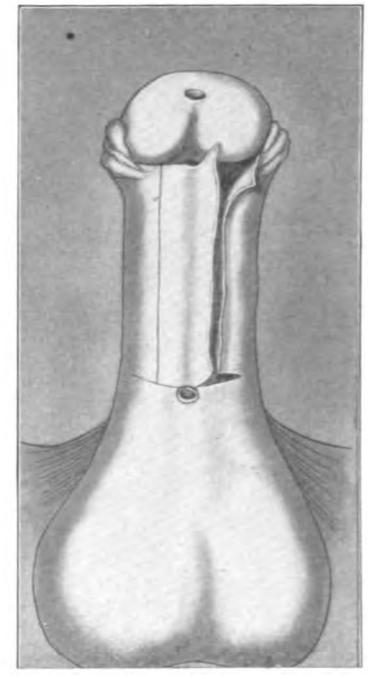

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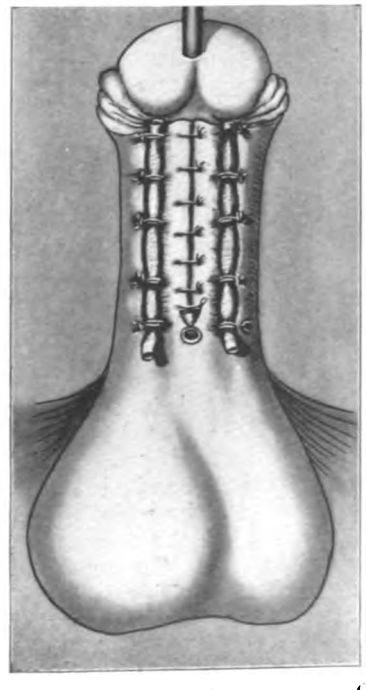
C. H. Mayo method.



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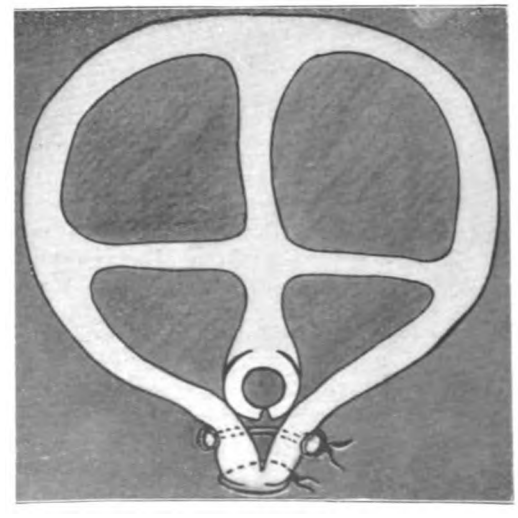


(h)

C. H. Mayo method.

its contents, and the tissues of the spermatic cords, as well as the inguinal lymphatic glands. It also includes the transplantation of the remnant of the urethra into the perineum.

Technique. An incision is begun opposite the internal abdominal ring on one side. It is carried down over the center of the inguinal canal around the edge of the scrotum, sufficient skin being left to insure the covering of the entire defect. Then the incision is carried up on the opposite side along the edge of the scrotum over the inguinal canal to a point opposite the other internal abdominal ring. A transverse incision is made to join the two here described, just below the pubis. The skin and superficial fascia are then dissected up and all the inguinal lymphatic glands carefully excised. The tissues of the cord are then isolated and treated as described in the operation for castration. The bleeding vessels are carefully caught with hemostatic forceps, in order to reduce the loss of blood to a minimum. It is desirable to make a very thorough dissection of the entire inguinal region, so that no infected lymphatic glands remain. The suspensory ligament is severed from its attachment to the pubic bone and then the crura are loosened from their attachment to the rami of the pubes.

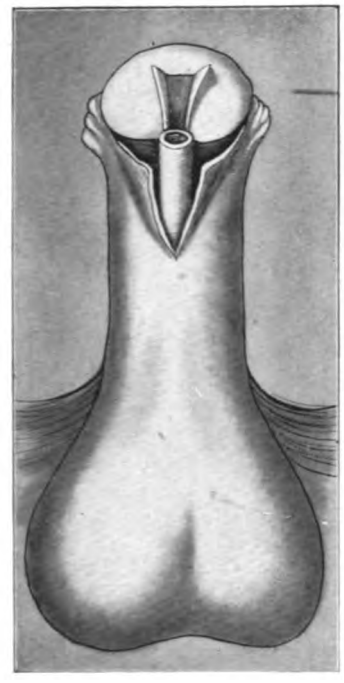
It now becomes necessary to insert a sound into the urethra, and the latter should be dissected out to a length so as to project half a centimeter beyond the level of the lateral skin flaps. After isolating this length of urethra it is cut off at right angles, and now the remaining tissues are loosened from their attachment backward. The branches of the internal pubic arteries should be caught before they are severed, because quite a little blood may be saved in this manner. All the blood vessels are then carefully ligated. The remnant of the urethra is split anteriorly and posteriorly to a distance of one-half centimeter, and is sutured directly into the lower edge of the wound in the perineum. A small retention catheter is introduced into the bladder and the incisions in the skin are closed throughout with sutures. If the dissection in the inguinal region has been quite extensive it is well to insert a small split rubber drainage tube on each side, in order to prevent the accumulation of serum. Ordinarily, however, the application of thoroughly fitting pads will make this unnecessary. An ordinary dressing is applied to the wound and a retention catheter is attached to a rubber drain, which is inserted in a bottle containing some antiseptic fluid.

This operation is usually performed in aged patients, and consequently it is important that it should be done quickly and that as little traumatism as possible be inflicted.

After-treatment. We have found it advantageous to permit these patients to sit up soon after the operation, on the second or third day, because this will not interfere with the healing, and because they are prone to hypostatic congestion, which can be avoided in this manner.

The retention catheter is removed on the second or third day and the patient permitted to evacuate his bladder spontaneously. In some cases we have permitted this from the beginning with perfect satisfaction.

Prognosis. Our personal experience with this operation has been confined to six cases, all of which had been previously operated for the relief of carcinoma, and in all of them there was not only a recurrence of the disease in the organ, but also a recurrence in the inguinal lymphatic glands. To our surprise, none of these patients has died as a result of a recurrence. The first patient lived for three years and died of pneumonia. The second lived for a period of six years without recurrence and died of an intercurrent disease. The third is alive after eleven years; the fourth we have lost sight of; the fifth is well after five years, and the sixth is too recent to be of any importance in this consideration, the operation having been performed not much over one year ago.



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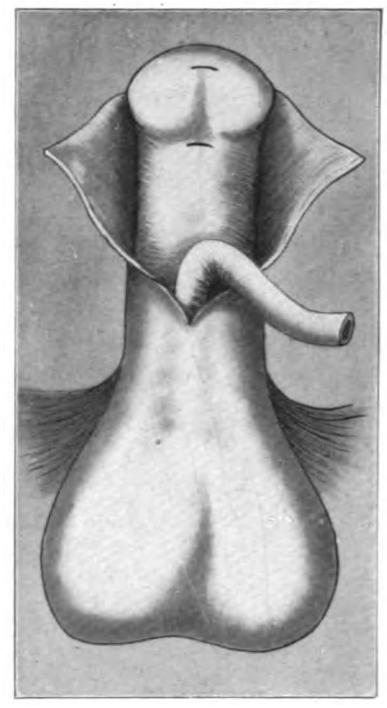
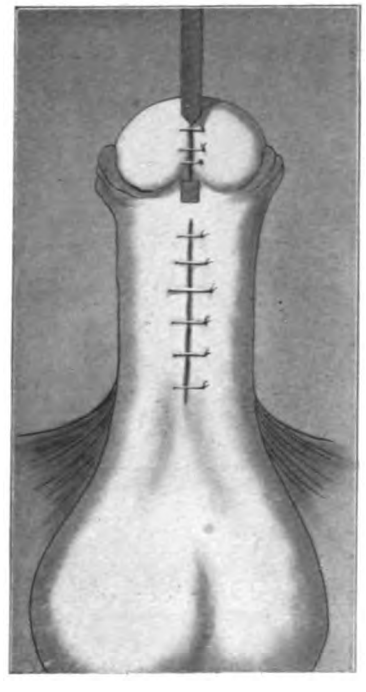


C. H. Mayo method. (j)



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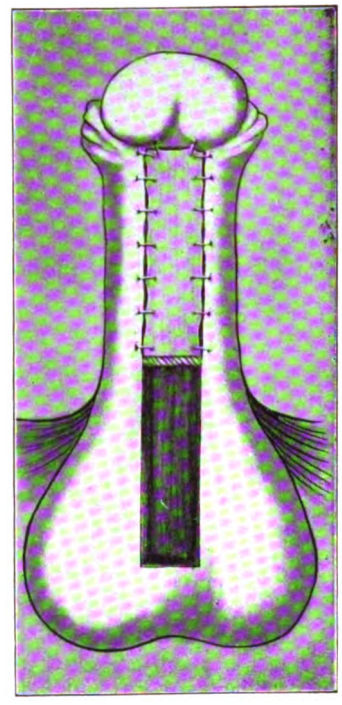
C. H. Mayo method. (l)



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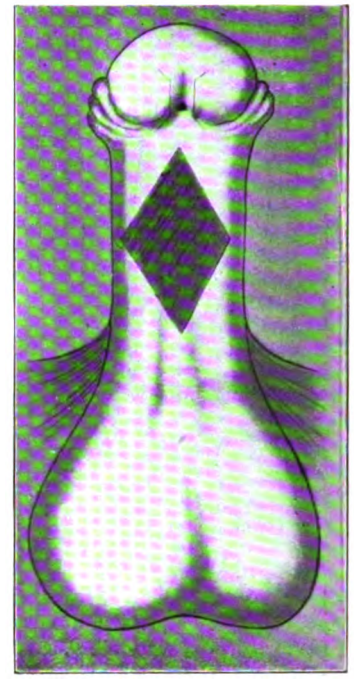
C. H. Mayo method.



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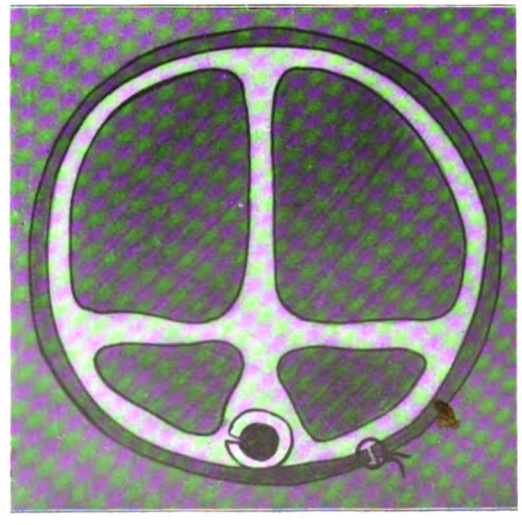

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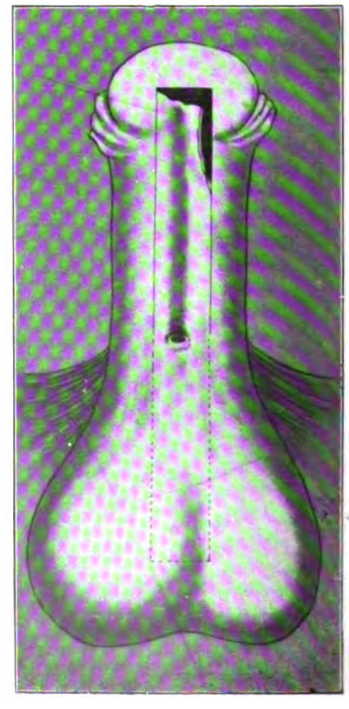
C. H. Mayo method.



(p)

but he also is free from recurrence. In all of these the operation was done with the greatest thoroughness, although each case at the time of the operation seemed hopeless, judging from the experience with carcinoma in other regions of the body after the lympathic glands have been involved. In all of these we employed the X-ray in the after-treatment with the exception of the first case.

HYPOSPADIAS

This deformity is so common that it seems proper to describe a simple method for its relief, especially as the presence of the defect seems to give rise to much mental suffering on the part of the parents of the afflicted child.

The urethra may open just at the beginning of the glans and then the operation to be employed is exceedingly simple. It was primarily described by Carl Beck.

An incision is made through the skin in the median line from its opening to a point from one-third to one-half the distance to the scrotum. Skin flaps are then dissected to either side, as shown in plate. The urethra is then dissected perfectly free this entire distance back, great care being taken not to injure its delicate wall at any time. The glans is then transfixed in the direction of the urethra by means of a very sharp trocar three millimeters in diameter. Caution should be taken to place this opening two or three millimeters above the small dimple in the center of the glans, which marks the point at which the meatus was normally intended, because if this is not done the organ will curve downward and there will still exist an uncomfortable deformity.

A pair of fine hemostatic forceps is then passed through the canal which has been made in the glans in this manner and the urethra is drawn through the opening in the manner shown in plate. It is then carefully sutured in place with two rows of catgut or fine silk sutures. The lateral skin flaps are then united as shown. In this manner the deformity can be almost completely corrected and the functional conditions are very greatly improved. The tissues in this region are so elastic that they readily accommodate themselves to these new relations, and the results of this operation are very satisfactory.

In case the urethra opens far back from the glans, another method is indicated which will supply a new urethra artificially formed out of the tissues of the prepuce, as shown.

The prepuce in cases of hypospadias is usually redundant and situated on the dorsal surface, overhanging the glans like a hood. The skin of the penis is noted for its thinness, having no adipose tissue, also for its looseness of attachment and elasticity. Where it is folded upon itself at its cervical attachment its character very nearly resembles mucous membrane.

The prepuce is extended as for circumcision, and two incisions are made about one inch apart, extending from its free border to its attachment at the penile cervix; the prepuce is unfolded, forming a loop of thin skin about six centimeters in length. Should this not be considered sufficient to reach from its attachment to the hypospadiac opening, the two incisions are extended back along the dorsum of the penis until sufficient tissue is obtained, when the two incisions are connected by a transverse one, and the flap of the skin lifted, but left attached to the cervix by the inner surface. Several sutures now close the lateral integument of the penis over the denuded area.

The pedunculated flap of prepuce is constructed into a tube with its skin or outer surface inside, by means of a number of catgut sutures. The penis is tunneled by means of a narrow bistoury or medium trocar and canula, through the glans, above its groove, along the penis to a point beneath the hypospadiac opening, when it is made to emerge at one side of, but close to, the urethra;

the tube of prepuce is drawn through the tunnel and sutured where it enters the glans and also where it emerges. At the end of ten days the flap of pedicle is cut through close to the new meatus. The second operation, made at a later period, consists of a perineal opening into the urethra and insertion of a Jacobs' self-retaining female catheter; this is the least irritating and can be left as long as needed, usually from five to eight days. An incision at the termination of the two urethras now admits of accurate coaptation by sutures, or the normal urethra may be mobilized to a sufficient extent to admit of its insertion into the caliber of the new urethra, where it is held by sutures and the external parts closed over this. Occasionally a little urine escapes into the urethra and the entire canal is best drained by passing several silk-worm strands of horsehair through the urethra and out alongside the catheter in the perineal opening. When union of the canals is complete the drains are removed and the perineal drainage will usually close itself in a few days. Horsehair and fine catgut have proved the best suture material for this form of plastic work.

Advantages. The advantages of this combined operation are:

1. A urethral tube of thin, elastic skin, nearly approaching mucous membrane, yet having no hair surface to occasion later complications.

In performing this operation it is especially important to bear in mind the following point: A sufficiently large flap must be made to provide a urethra that will reach without tension.

2. The trocar opening through the body of the penis must be very large, in fact so large that the circulation in the new urethra will not be interfered with after the organ becomes edematous.

3. A perineal drain for the bladder, with a self-retaining Jacobs' female catheter, must be employed.

4. A silkworm drain for the urethra should always be inserted.

This method is capable of application to the worst types of hypospadia cases.

If there is a marked groove in the penis, indicating the fact that the lack of closure of the canal depended upon a very small defect, a method which was most perfectly described and illustrated by C. H. Mayo will be found most useful.

Method of C. H. Mayo. The plates (a) show the original incisions, which are not nearly as far apart near the glans penis as they must be in order to secure an ample urethra. At (b) the lower flap is dissected up, which is presently to be utilized for covering the urethra formed of the upper portion. At (c) this urethra has been formed by suturing the free edges with fine catgut. At (d) the lower flap has been sutured upward, twisted 180 degrees upon its pedicle and its edges have been sutured to the edges of the wound from which the tissue was cut to form the urethral canal.

Another equally ingenious method is shown which has the advantage of not using long flaps, but there is the disadvantage of subjecting the tissues to a certain degree of tension, although this may be relieved in a measure by making a longitudinal incision through the skin on the dorsal surface of the penis from the glans to the pubis. At (e) the flap is being cut and elevated to produce the new urethra; at (f) this is further developed, showing also the perforation of the glans; at (g) the new urethra has been covered by the lateral flaps and in order to relieve the tension from these a row of mattress sutures has been applied, because without these the line of suture invariably opens. (h) represents a cross-section of the penis after all sutures have been applied.

The mattress sutures are tied rather loosely over a fine rubber drainage tube at each edge in order to allow for the edema which always appears.

Still another method applicable to cases of very slight degree, is shown at (i), where the urethra reaches to the base of the glans, or in cases as shown at

(j) in which the urethra can be mobilized and brought forward, the glans being perforated so that the end of the urethra will open at the proper point. In this operation it is again important to make ample flaps so that there will be no tension. At (k) this operation is shown as completed.

Another ingenious plan is represented in the plate at (l), in which a flap has been cut in the scrotum just sufficient to make the inferior lining of the urethra. This is sutured into two incisions, forming a flap which will make the anterior half of the urethral lining. After perfect union has been accomplished this flap is dissected up, leaving the urethra closed. The new surface formed may be covered with a long, narrow, skin graft, or it may be permitted to become covered with epithelium from the edges.

The objection to this method lies in the fact that occasionally a few hairs will grow in the part of the urethra formed from the flap taken from the scrotum, and the earthy phosphates contained in the urine are likely to collect on these hairs.

In many cases the penis is curved downward because of the shortness of the skin and fascia on the inferior surface. To overcome this deformity a transverse incision may be made through all of the tissues that bind the organ and then the wound can be spread lengthwise, as at (m).

Almost innumerable methods have been practised, as suggested by the conditions present in the particular case under consideration; at (o) is represented an ingenious plan of arrangement which prevents the incision in the urethra, and that in the skin, from coming opposite each other.

In all of these operations it is well to make a perineal urethrotomy through which a retention catheter is inserted, which is kept in place until the wound has healed. Neglecting to take this precaution usually, or at least frequently, results in failure.

While the retention catheter is in place it is important to give a small amount of aromatic sulphuric acid, or some other mineral acid, in distilled water every two or three hours to prevent the accumulation of earthy phosphates in the catheter. The dose must, of course, be regulated according to the age of the patient.

Another precaution which it is important to take into account in all of these operations is the fact that in many cases a satisfactory ultimate result can be obtained much sooner if the operation is carried out in a number of stages, and if these stages are not hurried, as one frequently loses much that has been gained by a little too much haste. One must also bear in mind the fact that considerable edema is to be expected and that consequently due allowance must be made for this in order to prevent the occurrence of pressure necrosis, which would otherwise result from the additional tension caused by the edema.

Again the principle that to obtain satisfactory results from operations for the correction of deformities we must overcorrect them, is illustrated strikingly in this operation.

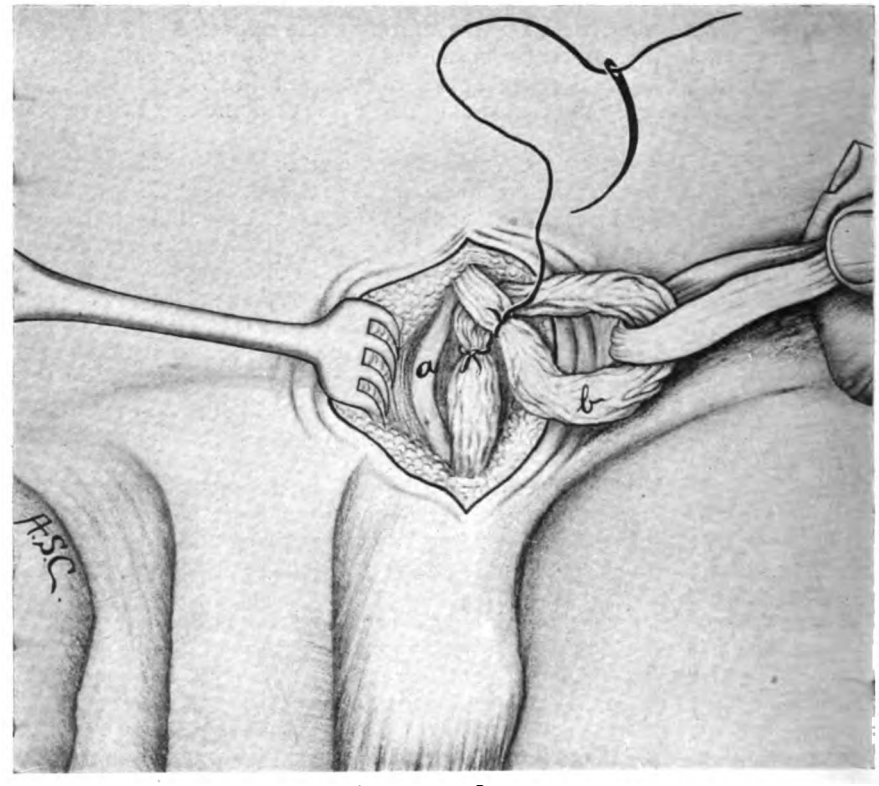
VARICOCELE

This condition is found mostly in boys above the age of sixteen.

Classes. There are three distinct classes under which all patients may be distributed from a clinical standpoint. In the first there are no symptoms; the patient discovers the deformity by accident or it is recognized by his physician incidentally. In the second class the patient has suffered severely from a dragging pain in the left side of the scrotum, extending into the groin and frequently into the back. This pain is increased when the patient is compelled to stand at his work or lift heavy weights. It is also much more severe when

he is tired, especially during warm weather. This is a marked feature of varicocele, that the number of cases regularly increases in our hospital service with the approach of warm weather and decreases in winter. In the third class the patient is neurasthenic and has attributed many forms of mental and physical suffering to the varicocele. He may suffer physically in the same manner as the patient in the second class, but the prominent symptoms are those of neurasthenia.

Diagnosis. There is a marked difference upon palpation in the right and left half of the scrotum. On the right side can be distinguished a hard, cord-



VARICOCELE OPERATION.

a vas deferens; *b* varicose veins the two stumps being sutured together with catgut suture to elevate the testicle in left side of the scrotum.

like structure—the vas deferens—extending the entire distance of the scrotum, with the testicle located at its lower end. On the left side these parts are almost concealed by a large accumulation of elastic, worm-like structures coiled upon themselves, giving rise to the sensation which has been compared to the manipulation of a number of angleworms. This is due to the great dilatation of the spermatic veins, which are in a varicose condition.

If the patient is placed in the recumbent position the veins become empty and can no longer be felt unless the affection has existed for a long time, in which case the walls of the veins themselves will have become thickened in the natural tendency of compensation, and then the change in the fullness of the vessels will not so completely alter the impression upon palpation.

Very rarely the condition is present upon both sides, and still more rarely

upon the right side alone, because the anatomical difference of the two sides favors the formation of varicocele upon the left.

The malady is so characteristic that it is not likely to ever be confounded with any other.

Indications for operation. In the first class operation is plainly not indicated, as in itself the condition is harmless so long as it gives rise to neither pain nor discomfort. It neither causes any other pathological state nor does it predispose to any; hence there can be no good reason for surgical procedure. In these cases it may be proper to advise the wearing of a well-fitting suspensory bandage, which will tend to prevent the further dilatation of the veins.

In the second class surgical treatment is strongly indicated, because, if properly executed, it will result in permanent relief in almost every case. It can be performed with safety to the patient, and it will disable him from work only for a short time.

In the third class it is necessary to determine whether there is any possibility of causal relation between the varicocele and the neurasthenia. If such a relation can be established the operation is plainly indicated. If there is as plainly no relation between the two, then the operation is not called for unless there seems to be reason to suppose that the presence of the deformity causes undue anxiety of the patient, which in turn causes or increases his neurasthenia. In such event the removal of the deformity might remove at least one cause of the neurasthenia.

If there is doubt it seems but fair that the patient be given the benefit thereof, and that surgical relief of the pathological condition be employed.

Technique. An incision three to four centimeters in length is made directly over the spermatic cord downward from a point just below the external abdominal ring. The blood vessels which appear in the incision are either caught at once between two pairs of hemostatic forceps and then cut, or the incision is made directly down to the tissues of the spermatic cord and the bleeding points thus caught with hemostatic forceps.

It is important that throughout this operation all bleeding be carefully controlled, in order to prevent infiltration of the tissues with blood or the formation of a hematoma, for both of these states are exceedingly annoying, not so much on account of their inherent importance as because of the anxiety they produce in the patient.

The cord is then brought up into the wound and the vas deferens, with a few of the accompanying small arteries and veins, isolated. This leaves the great mass of varicose veins in a separate bunch. After carefully carrying this separation from the external abdominal ring to a point half an inch from the testicle, the mass of veins is transfixed above and below with a double catgut ligature and tied in halves. The intervening portion is then cut away, caution being taken to leave a sufficient amount of tissue beyond the ligatures to prevent slipping. The two stumps are then united with catgut sutures to prevent the dragging down of the testicle, with its subsequent discomfort.

There is some danger of shortening the cord too much so that the testicle will be drawn up close to the external abdominal ring. This does not give rise to any pain, but the deformity may cause an increase in the neurasthenic condition of the patient. If possible the testicle on the operated side should hang only a little higher than the opposite one. It is quite important to have the result both cosmetically and anatomically as nearly perfect as possible.

The deep fascia is then sutured with fine catgut, and later the skin. It seems best to suture the fascia separately in order to prevent the infection of the deep tissues from the skin. An ordinary gauze dressing is applied to the wound and held in place by a suspensory bandage. The wound usually heals within a week, and the patient is able to perform ordinary work in two weeks.

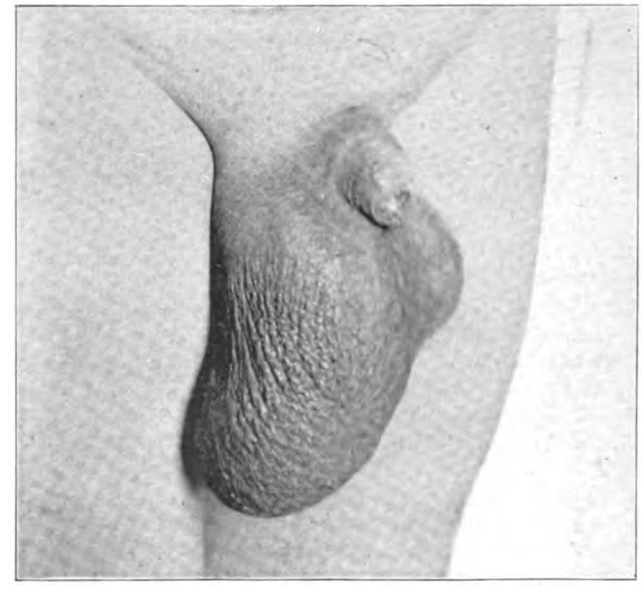
This is a very satisfactory operation as a rule, because it is thoroughly appreciated by the patient.

If one approaches the testicle too closely in the operation the resulting irritation is likely to cause the formation of a hydrocele. In order to prevent this in any case in which there seems such a likelihood, it is best to split the tunica vaginalis, evert it and suture it in the everted position before replacing the testicle in the scrotum. In cases in which this has not been done, and in which a hydrocele does occur after a varicocele operation, the injection method for the treatment of hydrocele (to be described directly) usually gives immediate and permanent relief.

HYDROCELE

This may affect either the tunica vaginalis of the testicle, or of the spermatic cord, or both.

The change is usually attributed to an acute trauma, or there may have existed an orchitis due to a specific urethritis. The physician is usually not



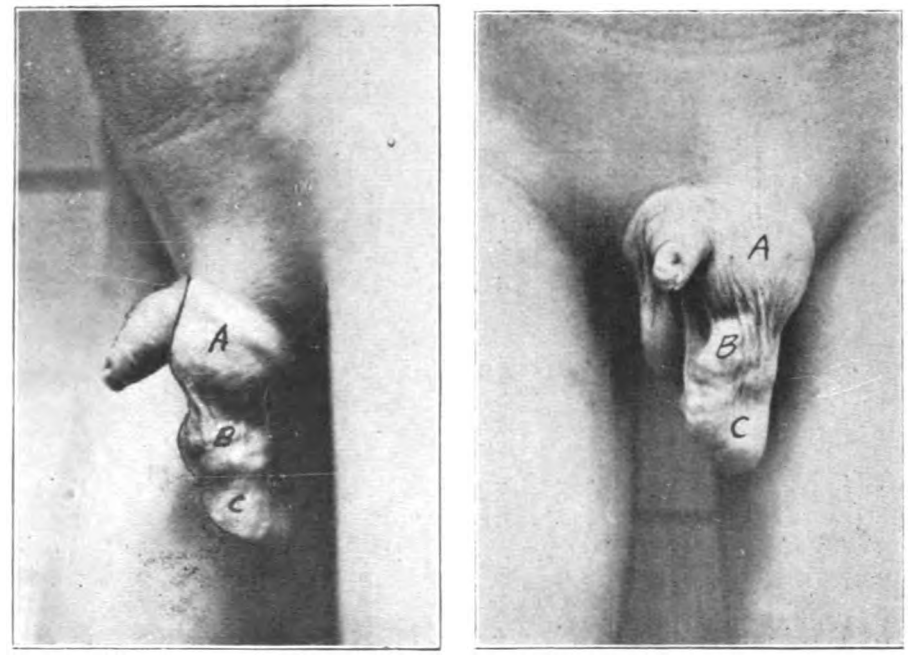
HYDROCELE.

consulted until the tumor has attained so great a size that its weight gives rise to discomfort, and it may annoy the patient on account of the deformity, or it may interfere with locomotion. It is usually, but not always, unilateral.

Diagnosis. Aside from the rare occurrence of sarcoma so soft in structure as to simulate fluctuation, the only condition with which hydrocele can be confounded is scrotal hernia. This is true especially in children in whom the contents of a hernia frequently give the same impression on palpation as the liquid contained in a hydrocele. This is especially true in hydrocele of the cord, which is located in the lower end of the inguinal canal and which can frequently be reduced through the inguinal canal into the peritoneal cavity. There is, however, this difference, viz., hydrocele will always reduce as a solid mass, only to reappear in a few moments without regard to the form

of truss that may be applied, while hernia will give the sensation of being composed of loose substance, and it will remain reduced if properly supported by a truss.

In hydrocele of the tunica vaginalis the *light* test is the most reliable. A small tube is applied to the side of the scrotum, then a light is placed upon the opposite side. If the light is seen through the tube it is an indication that the mass is composed of a sac containing transparent fluid. However, it sometimes happens that the hydrocele is so thick-walled in old patients that no light will penetrate. Occasionally the fluid may not be transparent, being



HYDROCELE OF THE CORD AND VARICOCELE.

The upper mass (A) is the hydrocele, the middle (B) the varicocele, and the lower (C) the testicle. Treatment—excision of the sac and 4/5 of the veins.

discolored by blood pigments, and then the light test may be misleading. A very simple test consists in grasping the scrotum, directly above the mass, between the finger and thumb. If the tissues of the cord can be plainly distinguished the case is one of hydrocele; if not, it is a hernia.

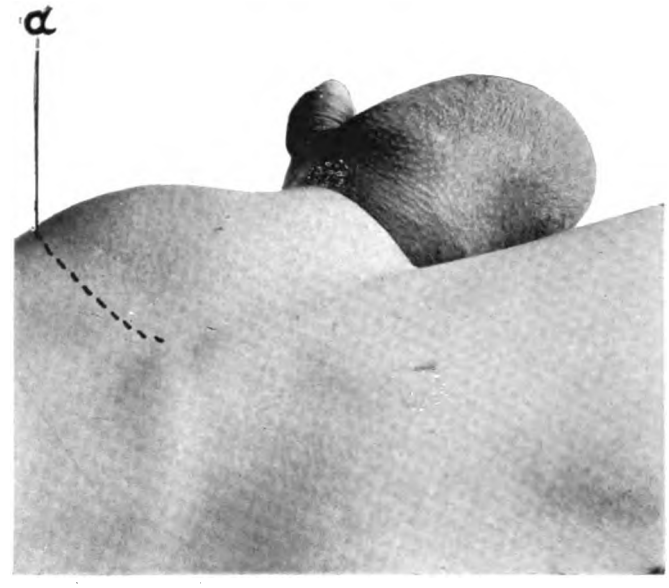
Abscesses may be distinguished by the evidence of inflammation; edema of the scrotum, because of edema elsewhere in the body. Tumors of the testicle are usually hard, and do not fluctuate.

Occasionally in old patients in whom the hydrocele has existed for a long time, especially if it has been frequently tapped, the walls of the cyst undergo calcareous degeneration, giving the impression of a hard tumor. This has repeatedly been mistaken for sarcoma or enchondroma, a mistake which is quite unfortunate, because it is usually not discovered until after the organ has been removed.

Technique in children. In children simple tapping will suffice to bring about a permanent cure. This may be repeated a few times if necessary, and if not permanently successful it should be followed by the injection into the

sac, after the latter has been very carefully emptied, of a few drops of ninety-five per cent. carbolic acid. The canula of the trocar should be closed and left in place while the carbolic acid is distributed over the entire surface by carefully massaging the scrotum. After a few minutes the canula should be opened, and whatever fluid may have again accumulated, together with the carbolic acid, should be drawn off. In small children five drops of a thirty per cent. solution of carbolic acid in glycerine will suffice, if the sac has been carefully emptied before this fluid is injected. It does not matter if all of this fluid remains in the sac, as the amount is not sufficient to cause symptoms of poisoning from absorption.

During the entire manipulation the external abdominal ring should be compressed, in order to prevent the introduction into the peritoneal cavity of



ENCYSTED HYDROCELE OF THE CORD EXTENDING UPWARDS AND FORMING A LARGE TUMOR IN THE ABDOMEN. A, UPPER LIMIT OF ABDOMINAL TUMOR.

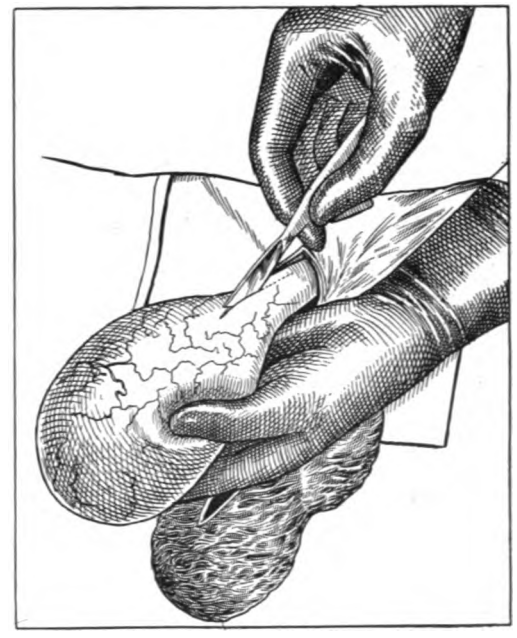
any portion of the carbolic acid, in case the upper end of the tunica vaginalis has not yet become entirely closed.

In hydrocele of the cord in children tapping alone almost always suffices. If this is not the case, it is well to make a longitudinal incision, opening the hydrocele and tamponing the cavity with iodoform gauze. After a few days the gauze may be removed and the wound will heal completely in a short time. It does not matter that the inguinal canal is thus left wide open after the hydrocele of the cord which closed it has been emptied and can consequently no longer act as a plug. During the short period that the child will be compelled to remain in the recumbent position the canal will contract sufficiently to prevent the protrusion of a hernia.

Technique in adults. If the patient can conveniently abandon his work for one or two weeks, it is usually best to advise the operation for radical cure, to be described presently. If he cannot leave his work and desires only temporary relief, tapping will accomplish this. If he cannot remain away from his work, but still desires to obtain some hope of a permanent cure, without a certainty, it may be well to make use of the ninety-five per cent. carbolic

acid, just mentioned, with a change in the quantity to be employed. After aspirating the fluid, from one to two drachms of ninety-five per cent. carbolic acid is injected and forced into contact with every portion of the lining of the sac by massage. The acid should be left in contact with the surface for at least five minutes, then it should be forced out through the canula, which, of course, has in the meantime been kept closed. The patient should then be put to bed for a few hours, after which he may resume his occupation. In our own practice we have frequently applied this treatment on Saturday evening, and the patient has always been able to resume work with perfect comfort on Monday morning.

In about one-half of all the cases this method will result in a permanent



THE WYLLYS ANDREWS METHOD.

cure, and it is worth while to explain to each patient coming for treatment the first time, that in about one-half the cases this simple method will accomplish everything he may desire. The method has the further advantage of being painless. Recently we have followed the plan practised by Coley of completely aspirating the fluid contained in the hydrocele and then injecting five drops of a ninety-five per cent. solution of carbolic acid, or fifteen drops of a thirty per cent. solution in glycerine, and leaving this in the sac. The proportion of cures seems to be about equal to that just described.

Radical operation. An incision, one and one-half inches in length, is made over the anterior surface of the side of the scrotum involved, directly down through the tunica vaginalis, which will permit the fluid to escape. The inner surface of the sac and the surface of the testicle are carefully inspected in order to detect any tubercles which might account for the accumulation of fluid. If present they are carefully removed, preferably with the knife of an electro-cautery. If none are found the tunica vaginalis is everted over the testicle and held by a few stitches of catgut; then the testicle, together with its everted tunica vaginalis, is replaced in the scrotum. Great care is exer-

cised to secure absolutely perfect hemostasis so as to prevent any accumulation of blood in the scrotum after the operation. The deep fascia is first sutured with catgut and then the skin is united. An ordinary dressing is applied and held in place by a suspensory bandage.

It is very important to inspect the testicle carefully in order to discover any small cysts which may be present on the surface, either because of the adhesion of a portion of the tunica vaginalis, or of accumulation of serum underneath the portion of this structure covering the testicle. In either event the anterior layer of tunica vaginalis is cut away entirely in order to exclude the possibility of a recurrence.

The wound heals in a few days, and in a week the patient is able to follow his usual labor. The operation is so simple, safe and satisfactory in its results that it seems foolish for one to carry a hydrocele about for years and go through the annoyance of repeated tappings when he might in a few days obtain permanent and perfect relief.

CYSTOTOMY

During the past few years it has become an almost universal practice to open the bladder through a suprapubic incision for the removal of stones and foreign growths, and for permanent drainage of the bladder from any cause. The operation in itself is relatively simple.

Preparatory treatment. Before undertaking any operation upon the bladder it is desirable that the urine should be as nearly aseptic as possible. Measures should be taken to make the urine as nearly normal as the conditions of the patient will permit. That affection for which the operation is required usually predisposes to an abnormal state of the urine, and frequently not only the bladder, but also the kidneys are diseased. If the urine contains septic material this may be changed by dilution, the patient being given large quantities of distilled water, or, if this is not agreeable, one of the various mineral waters in large quantities. Such course will reduce the septic character of the urine to a great extent. If the urethra is permeable to the passage of a catheter, irrigation of the bladder with a mild, non-irritating antiseptic solution, such as boric acid; 1 to 1,000 solution of permanganate of potash; 1 to 2,000 solution of nitrate of silver; a saturated solution of acetate of aluminum; or a solution of any one of a number of recently produced silver salts, may be used. These silver salts have the advantage of not being precipitated by contact with urine. These solutions may be used in from one to ten per cent. strength, and from one to two ounces may be safely left in the bladder after conclusion of the irrigation. If a solution of nitrate of silver is used the bladder should first be irrigated repeatedly with distilled or boiled water, as otherwise all of the silver will at once be made useless by being precipitated in the form of silver chloride. Adding an ounce of strong alcohol to a pint of saturated solution of boric acid makes one of the best solutions for irrigation.

Care should be taken not to irritate the bladder with any of these solutions. If it is found that one irritates more than the other it should be avoided. The bladder should be filled moderately full and then the fluid permitted to escape, or the bladder may be irrigated with a constant stream through a double catheter, one tube serving the purpose of introducing the fluid, the other of emptying the bladder. A repeated examination of the urine will determine whether this treatment reduces the amount of septic material regularly found.

There are a number of antiseptics that may be given internally as urinary disinfectants. Of these five grain doses of boric acid given with half a pint of distilled water, or mineral water, every three hours; the same dose of salol,

or of urotropin; or one-grain doses of methylene-blue given in the same manner, are probably the most useful. There is, however, this fact to remember, that urine usually is most septic if the bladder is not at any time completely evacuated, and consequently but a slight amount of benefit is to be expected unless the residual urine is removed once or twice, or oftener, each day, and the bladder carefully irrigated.

Irrigation. Just before the operation the bladder should again be carefully and repeatedly irrigated so that any accumulation of septic material may be thoroughly washed away and any remnants that cannot be so washed away may be thoroughly diluted. In many cases the bladder contains weakened points and consequently great care should be used in this final irrigation, which is usually performed after the patient has been anesthetized, not to fill the bladder with too much force for fear of causing a rupture at some frail point. After this irrigation has been completed the bladder should be filled moderately either with air or water. The latter may be injected through a catheter by means of an ordinary bulb syringe, not more than eight ounces being introduced. The quantity can be measured by the size of the bulb used. In case air is used, it is best to leave the catheter in place after the bladder has been irrigated and to attach it by means of a glass tube to a rubber bulb. The incision is then made through all the tissues down to fat in the space of Retzius. Then the bladder is pumped full of air and it can be observed as it expands in the depths of the wound.

Technique. Many surgeons prefer to make a transverse incision just above the pubic bone, down to the aponeurosis of the recti muscles, and then to cut longitudinally between these muscles. We have made this incision, as well as the longitudinal one about to be described, and have found both equally satisfactory.

The field of operation has, of course, been carefully shaved and prepared; then a longitudinal incision is made in the median line directly upwards from the os pubis, a distance of five centimeters. The muscles are separated and the fat above the pubis and front of the bladder exposed. This contains a number of veins of considerable size which usually extend transversely or obliquely across the incision. They should be grasped with hemostatic forceps on either side, cut and ligated at once. The wound is carried through the fat down to the wall of the bladder. In making this dissection great care should be taken not to extend the incision too high for fear of entering the peritoneal cavity. This is not likely to occur, however, if the bladder is filled with water or air, unless the viscus is pendulous and displaced backwards. In such event the peritoneum may approach the os pubis and may have to be shoved upwards and held out of the path of operation by means of retractors. A suture is then applied to the wall of the bladder in the upper angle of the wound for the purpose of securing it against separation from the anterior abdominal wall. Two other stitches are applied in the bladder wall with curved needles one centimeter to each side of the median line. Forceps should be applied to each one of these stitches, and the bladder wall drawn forward gently. A longitudinal incision is then made, from one to three centimeters in length, according to the object of the cystotomy, and the edges of the wound grasped with fine-toothed forceps and held open while the interior of the bladder is being exposed. As soon as this incision is made the fluid (or air) contained in the bladder will escape and the bladder walls begin to contract. If a stone is present its size may be determined and the incision in the bladder wall increased if necessary. The position of the stone is determined with the finger, and it is grasped by means of stone forceps in its narrowest diameter and withdrawn from the wound in the bladder with the gentlest possible motion. The interior of the bladder should then again be

examined for further stones, and this should be repeated until all such have been removed. If a tumor is present an assistant should introduce two or three fingers into the rectum and force the tumor toward the wound so as to facilitate its examination and removal.

The method of removal of a tumor will depend largely upon its size and location, and must be determined upon general principles in each case.

If the operation has been undertaken for the purpose of securing permanent drainage, the incision should be made as near the os pubis as possible, and be only just large enough for the purpose of permitting careful digital exploration. Several purse-string sutures should then be applied to prevent leakage, and a retention catheter introduced. The wound should be tamponed around this retention catheter and the stitches in the bladder wall passed through the edge of the wound and tied just sufficiently tight to hold the anterior wall in close apposition with the abdominal wall. A few silkworm gut sutures are then applied, so as to grasp the wound on each side, and to take a small bite in the anterior wall of the bladder above the point of incision, and two small bites, one on each side of the incision in this portion of the bladder. These sutures are left untied until the first dressing, which occurs a few days after the operation, when the gauze tampon and the three first stitches may be removed and the silkworm sutures may be tied, leaving only a space open through which the drainage tube passes. If the bladder has been in a septic condition, it is often best to pass two ordinary rubber drainage tubes one-half a centimeter in diameter, perforated with several small openings in the end. It is then possible to irrigate the bladder by permitting the fluid to flow in through one of these tubes and out of the other; and in case one or the other becomes occluded with mucus or blood the free one will suffice to drain.

After-treatment. The most important point in the after-treatment consists in giving the patient large quantities of pure water to drink. If the patient is at all shocked by the operation it is wise to give him a saline transfusion at once, or to give him an enema of half a pint of normal salt solution every hour.

It is well to give the patient from two to five drops of dilute aromatic sulphuric acid in half a pint of distilled water every hour during the day, and every two to three hours during the night. This will prevent the accumulation of earthy phosphates in the bladder or in the drainage tubes.

The bladder should be irrigated with a saturated solution of boric acid from two to six times a day, according to the character of the urine. If two rubber tubes are employed, sufficiently long for the ends to project into an antiseptic solution in a bottle tied to the side of the bed, the patient will usually remain perfectly dry. It is a good plan to insert a glass tube into the end of the rubber tube, so that its weight will keep it from becoming dislodged from the bottle. By placing a Y-shaped glass tube in the course of the tube leading from the bladder to the bottle, and having one of the short legs of the Y attached to the tube coming from a fountain syringe suspended from a point higher than the bed, from which water is permitted to drop constantly, the rubber tube will act as a syphon and this will serve to keep the bladder empty and the patient dry. If the rubber tubes give rise to pain their position should be changed occasionally. The bladder contracts and then these tubes cause irritation by pressing upon the posterior wall of the organ.

If the operation is done for the removal of a stone from a healthy bladder containing nearly normal acid urine the wound in the bladder may be closed by a double row of catgut sutures, which are not permitted to penetrate the mucous membrane, however. The space between the bladder and the

abdominal wall should always be drained thoroughly in these cases for fear of extravasation of urine. A soft rubber retention catheter is placed into the bladder through the urethra in such instances and carefully fastened in place, so as to keep the bladder thoroughly drained. If there is any doubt about the septic condition of the bladder it does not seem wise to close its wall completely.

If the operation is performed for the purpose of securing permanent drainage, the smaller the opening in the bladder the better will the operation serve its purpose. In these cases it is well to make the bladder opening as near the urethral opening as possible. If a permanent drainage is employed, the bladder should be irrigated at least once a day with some mild antiseptic solution, and it is advantageous to change the character of this solution repeatedly, because an occasional change will increase the usefulness of any of the various antiseptic solutions which have been mentioned in this connection.

TUMORS OF THE BLADDER

In the removal of tumors of the bladder it is important to have a free view of the field of operation. This is secured by placing the patient in the exaggerated Trendelenburg position and making a median abdominal section, extending from the pubis to the umbilicus, and tamponing all of the intestines and the omentum out of the way into the upper portion of the abdominal cavity. The bladder has of course been previously thoroughly irrigated, as before described, and is either entirely empty or moderately distended with air.

It is usually well to place these patients on a diet of milk and egg albumen for a few days before the operation and give them capsules of ten grains of gallic acid every two hours for one or two days before the operation, which will serve to reduce the hemorrhage greatly. This of course is not necessary but is of advantage.

The pelvic cavity behind the bladder is filled with a gauze tampon to catch any slight amount of urine and blood. The wall of the bladder is then caught with fine-toothed forceps and incised. Whatever urine may be present is carefully sponged away. Then the tumor is excised freely. If it includes a ureter the latter is picked up and implanted into the bladder wall later, according to the method already described. If neither the ureter nor the osteum of one or both ureters is involved, then the bladder wall is sutured. The first row of stitches is made of fine chromic catgut, preferably used double. This is applied after the manner of the Connell suture in intestinal surgery, which has been described and illustrated elsewhere herein. A second row of sutures is passed over this after the manner of the Lembert suture in intestinal surgery. This may be done with a fine, ten-day catgut, or with silk or linen. It is not necessary to apply drainage, either to the bladder wound or the cavity of the bladder; a retention catheter is likely to cause more harm than good.

If the ureters are involved to an extent making an implantation into the bladder impossible the case is usually hopeless, but it may be worth while to make an oblique implantation into the colon according to the method previously described.

URETHROTOMY

Indications. In urethral strictures which cannot comfortably be kept open by means of bougies passed regularly by the physician, or in this condition accompanied by a constant or interrupted discharge, or in the presence of pain, or other abnormal conditions which can be attributed to a stricture, the latter should be thoroughly divided. This is true even in cases in which annoying

nervous symptoms referable to strictures persist where it is possible to pass a sound of normal size.

These patients usually give the history of one or more attacks of gonorrheal urethritis, followed in time by an obstruction to the flow of urine, which may be only slight or almost complete. During the entire time there may have been a certain amount of urethral discharge, possibly only a drop in the morning. This may be associated with an irritable bladder, which refuses to retain urine for the normal period of time. There may be a sensation of scalding during micturition.

Diagnosis. The urethra should be thoroughly irrigated with a saturated solution of boric acid, or a solution of 1 to 1,000 permanganate of potash, before an instrumental examination is made. If time permits, it is wise to give from five to ten grain doses of boric acid or salol, or both, from three to six times a day, with half a pint or more of pure water, preferably hot, for several days. This will have a tendency to disinfect the bladder and the urethra. In many cases it is wise to give five-grain doses of quinine with a pint of hot water, three times a day, for one or two days before attempting an instrumental examination of the urethra. Many patients who have repeatedly suffered from severe sepsis, characterized by a chill known as "urethral," followed by severe fever, after an instrumental examination, have remained entirely free from these symptoms after future examinations of the same character if preceded by the use of quinine. The same is true regarding the gradual dilatation of the urethra by means of hard rubber bougies or steel sounds.

After the necessary preliminary preparation a moderate-sized urethral sound, lubricated with some sterile oily substance, is introduced with great care to the prostatic urethra, but not through it. If this sound encounters any obstruction a smaller one is used and the size reduced successively until a very small sound is tried. The smaller the sound, however, the greater must be the care in its introduction, and whether the sound be large or small it must always be inserted absolutely without force, for fear of doing injury to the delicate structure of the canal. If the original sound passes to the prostatic urethra, then successive sounds are introduced until the largest one has been secured that can be freely passed.

If any one of the sounds used meets an obstruction it is withdrawn and the depth of the obstruction carefully noted; also the size of the largest sound which will just pass this obstruction.

Internal urethrotomy. The urethra is next examined by means of a bulbed sound, the bulb having approximately the shape of an olive. These sounds are introduced in successive sizes until one is reached which will just pass the constriction. It is then passed on and may possibly encounter further constrictions, which it may or may not pass. If a smaller constriction is encountered, smaller bulb sounds are used to determine the size of such obstruction. The locations of all constrictions are carefully noted as to their depth and size. After all these facts have been determined an Otis urethrotome is introduced into the urethra and the indicator turned to the point registering the size of the smallest stricture, the point of the urethrotome being inserted one-half inch beyond the location of this stricture as determined by the measurements. The concealed knife is directed either downwards or upwards, so that the cut will be precisely in the median line. It is then withdrawn a distance of an inch or a little more, when the knife is forced into its position of concealment. The urethrotome is then withdrawn and the urethra further measured for other strictures; if found they are treated in the manner just described.

After repeated examinations determine every portion of the urethra to be of normal size, as measured by the bulb sounds, and after this examination

has indicated the urethra to be uniform in size, a large urethral sound, No. 30 to 40 French, according to the size of the patient, is introduced. If the bleeding is profuse a large catheter is passed and the cut surface is held against this catheter by means of rubber adhesive straps applied circularly over a padding of cotton at least one-half inch in thickness. In this manner hemorrhage can easily be controlled. The catheter is left in place for twenty-four to forty-eight hours, and the bladder irrigated through it with one of the various antiseptic solutions before mentioned, from one to six times each day, according to the character of the urine.

After-care. The same after-treatment which has been described for cystotomy, so far as the administration of large quantities of water and internal antiseptics are concerned, should be followed. After the fifth day steel urethral sounds or hard rubber bougies are introduced, at first once every three or four days, then every second day, then every day, and when the urethra has been permanently dilated so that it will comfortably take the largest desirable sound the frequency of treatment may be reduced again; at first they are to be used every second, then every third, then every fourth day, etc., until presently they are introduced but once a month. This should be continued for many months until the surgeon has evidence that no further contraction will take place. It is to be remembered that a urethra which has once been strictured can be kept open with much less difficulty and with much greater comfort if a series of sounds is passed once a month, than if the stricture is permitted to reform and has to be gradually dilated.

In case it is impossible at the primary examination to pass a sound of any size through the stricture the patient should be placed in bed and the further treatment which has been mentioned should be prolonged. Patients should also be given hot baths, and after this treatment has been continued for some time it will be found that the stricture is not so tight as it was at the beginning of this attention. It will then usually be possible to introduce a filiform bougie. This should be attached to the end of a conical sound, and with this the stricture slightly distended. After this has been accomplished the conical sound is replaced with the urethrotome and the stricture cut as described before. Entire urethrotomy is, however, not safe in strictures located beyond the distal half of the membranous portion of the urethra, because the use of this method is likely to be followed by severe extravasation of blood and sometimes by extravasation of urine; the latter may result in sloughing of a great amount of tissue.

EXTERNAL URETHROTOMY

Special requirements and technique. In very tight strictures of the membranous portion of the urethra it is probably always best to do an external instead of internal urethrotomy. If the stricture is tight, however, internal urethrotomy should always precede the external, because with a filiform bougie attached to the conical sound, and later to the urethrotome, as has just been described, it is practically always possible to split the stricture smoothly and with the infliction of as little unnecessary traumatism as possible to the urethra; moreover, after internal urethrotomy has been performed a grooved steel sound can be introduced into the urethra and then external urethrotomy done without great difficulty.

It is quite the opposite if an external urethrotomy is undertaken in a tight stricture instead of first performing an internal urethrotomy, because the exceedingly small opening in the strictured portion of the urethra can often be found only with the greatest amount of difficulty, if at all, and in the search for this opening a great amount of tissue is frequently destroyed. Had the

internal urethrotomy been performed in the same case before the external operation was attempted, all such traumatism would be avoided. If, however, it is impossible to introduce a filiform bougie through the stricture, and consequently impossible to do an internal urethrotomy, an attempt may be made at finding the remaining opening through an external incision. Occasionally the surgeon may be more fortunate in his search than he could reasonably expect, and in this way may discover the remnant of the original canal. If this fails, however, after a reasonable attempt, it is best to perform a suprapubic cystotomy and introduce a sound into the urethra by the way of the bladder, and carry this down into the wound of the urethra to the point of the stricture, and then cut down externally upon the point of this sound. With this guide it will then be possible to slit open the stricture. Preferably a fine probe is used, which is introduced from the upper portion of the stricture downward, the latter being at the end of the sound which has just been introduced from the bladder.

After-treatment. The wound is then left open and dressed with ordinary antiseptic dressings. The remnant of the mucous lining of the urethra will begin to proliferate and form a covering of mucous membrane over the adjoining portion of the wound. Presently it will show a tendency to close in upon itself and reproduce the original canal. In the meantime care should be taken not to permit the distal end of the urethra becoming again contracted. This may be prevented by the introduction of steel sounds once every two or three days. After the urethra shows a tendency to close a catheter should be introduced into the bladder through the entire length of the urethra and the wound permitted to heal around this catheter. The same precautions for the dilution of urine which have been described after suprapubic cystotomy should be employed in these cases. Occasionally an external urethrotomy is indicated by the presence in the urethra of a fistula, showing the existence of the stricture to the distal side of the fistula. The operation in such cases is the same as that which has just been described.

RUPTURE OF THE URETHRA

The most urgent demand for an external urethrotomy is a severe traumatism of the urethra. This is usually caused by falling astride some hard substance, such as a beam or board in buildings being constructed, or falling astride a wagon wheel by teamsters, or falling upon the pommel of the saddle by horsemen, or any other similar accident. The patient suffers severe pain in the region of the perineum; there is usually a flow of a variable amount of blood from the urethra; there is an obstruction to the flow of urine, and upon introducing a catheter into the urethra it brings blood, but no urine. If the injury is recent these may be all the symptoms determined. If it has existed for a longer time there is severe ecchymosis, there may be marked edema, and there frequently is an area of necrosis, which varies with the severity of the injury and length of time that has elapsed since its occurrence.

If the catheter passes the obstruction and enters the bladder, this will be indicated by a flow of urine. In such event, it is wise to irrigate the bladder with some antiseptic substance and to leave the catheter in place, for fear of not being able to reintroduce it, for the purpose of preventing extravasation of urine by the perfect draining of the bladder, and also for the purpose of acting as a splint in directing the process of healing in the ruptured urethra. If the surgeon is not fortunate enough to introduce the catheter into the bladder without the use of force, he should abandon the

attempt without having increased the existing traumatism, the only rational means then of treating these cases being with an external incision.

Technique. The patient is placed in the lithotomy position; the skin prepared for operation; a longitudinal wound made upon the end of the urethral sound which has been introduced to the point of obstruction. This sound will indicate the location of the distal end of the urethra. If it is difficult to locate the proximal end of the urethra this can usually be effected by making gradual pressure upon the bladder, thus forcing out some of the urine, which will indicate the proximal end of the canal. The incision is then prolonged until it passes the proximal end of the urethra for about an inch. The two extremities of the urethra are then united by means of fine catgut sutures for about two-thirds of their circumference, the most superficial third being left for drainage. A catheter is then introduced through the entire urethra into the bladder, and the remaining portion of the wound permitted to heal by granulation.

It has been our experience that a complete union of the urethra in these cases can be accomplished much more rapidly and perfectly if the entire circumference of the urethra is not sutured at once at the time of the first operation.

After-treatment. The after-treatment is the same as before mentioned. The retention catheter is left in place until the wound in the urethra has apparently completely healed. If the patient does not come under the surgeon's care until a considerable portion of the urethra has become necrotic, it may be necessary to excise this and bring together portions of the urethra a considerable distance from each other. This, however, can be done with safety and with comfort to the patient.

RESECTION OF THE STRICTURED URETHRA

The same conditions may be established if a portion of the urethra has been entirely destroyed by inflammatory processes, leaving a cicatricial stricture, in which a recovery of the lumen of the urethra is impossible. In such cases the cicatricial stricture is entirely excised and the urethra above and below united by means of fine catgut sutures, the most superficial third of the circumference of the urethra being again left open. A retention catheter is introduced and the wound dressed in the usual way.

Prognosis. The prognosis in all of these cases treated for a long period of time after they have apparently completely recovered is relatively very good, provided no further gonorrheal urethritis occurs. It is, however, to be remembered that these patients should return to the surgeon from time to time, so that he may determine the tendency to recurrence of stricture at a period when the condition can be most easily relieved, and if any such tendency exists, it should be overcome by the careful use of sounds before it has reached an advanced stage.

VASECTOMY

The excision of the vas deferens may become necessary on account of tuberculosis of this organ, which is not uncommon, or on account of a malignant growth (sarcoma extending to the vas deferens from the testicle being the most common cause), or the operation may be performed with a hope of causing a reduction in the size of an hypertrophied prostate gland. It is likely that this operation will be employed for the purpose of securing sterility in patients, either physically, mentally or morally impaired to such an extent as to make their progeny dangerous to the community at large.

Technique. The extent of the procedure will depend upon the condition for which it is to be performed. If a considerable portion of the vas deferens is diseased the incision should extend from the external abdominal ring down to the lower portion of the scrotum. The tissues of the cord being exposed, the vas deferens will be recognized as a hard, round cord. This, in case of malignancy, should be removed, together with all the tissues of the cord and the testicle. In case it is tubercular and the disease has not penetrated the organ and infected the surrounding tissues, it is separated from the adjacent parts to a point two centimeters or more beyond the affected portion. It is then ligated with catgut at each end and excised.

If the entire vas deferens is tubercular it should be carefully dissected as far up in the inguinal canal as is possible without fear of breaking it off. A syringe with a blunt-pointed needle is then filled with ninety-five per cent. carbolic acid. The needle is introduced into the vas deferens and the carbolic acid injected very slowly into its lumen. After the acid has been in contact for five minutes the syringe is filled repeatedly with strong alcohol, which is also injected through the lumen of the vas deferens in order to prevent the carbolic acid from causing too much destruction.

Should the operation be intended only for the interruption of the continuity of the canal, a small incision two centimeters in length is made opposite the external abdominal ring, the tissues of the cord are brought into the incision, the vas deferens is separated from the other structures of the cord. two catgut ligatures are applied a centimeter apart, and the intervening portion excised. The tissues of the cord are then replaced and the wound in the skin closed with one stitch.

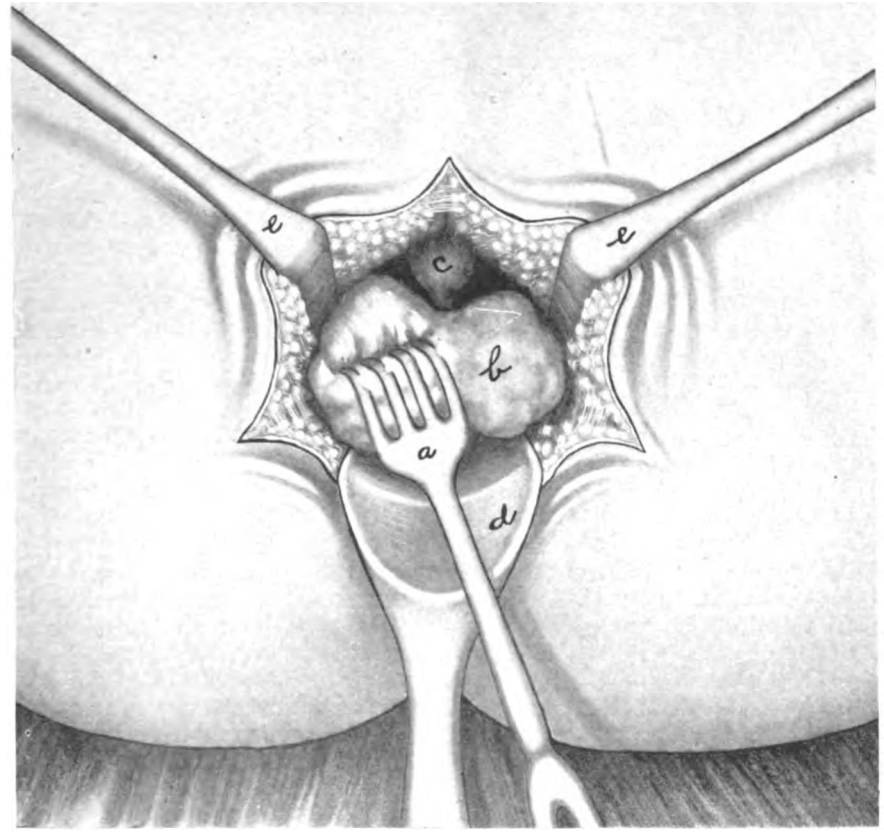
Regarding the effect of this operation for the relief of hypertrophy of the prostate gland, we should say that there are undoubtedly certain patients who are permanently benefited by this form of treatment. It is, however, impossible to determine beforehand which patients will be so improved, and consequently it is impossible to make a reliable prognosis. The operation in itself is simple; it can easily be performed under cocaine anesthesia; it is not accompanied by pain; and results in no deformity. All of these reasons make it one which should not be condemned, although the relative number of permanent recoveries is not sufficient to warrant its general adoption.

PROSTATECTOMY

This operation has grown greatly in favor during the past few years, principally because attention has been paid to its careful technical development. It is performed entirely for the removal of hypertrophied prostate glands. We will only describe the perineal method, because the suprapubic method virtually corresponds to the operation for suprapubic cystotomy, to which is added the enucleation of one or more lobes of the enlarged prostate gland projecting into the bladder. For all cases of prostatic enlargement in which there is not a distinct projecting lobe into the bladder, we would perform the perineal operation.

General considerations. In the consideration of this operation it must be remembered that patients upon whom it is performed are usually advanced in years, because hypertrophy of the prostate gland occurs most frequently at such time. There has been an obstruction to the passage of urine, which has usually resulted in the accumulation of residual urine in the bladder, predisposing to infection and consequent cystitis. Many of these patients have infected their bladders mechanically by the use of septic catheters; in many these conditions have resulted in the formation of stone; in many, again, the infection has advanced by one or both ureters into the pelvis of the kid-

ney, giving rise to a pyelitis; and still again many are found suffering from a chronic nephritis, which is not uncommon in patients advanced in years, though there may be no direct mechanical cause for its occurrence. All these facts would indicate that this operation, as a rule, is done on a class of patients who are not well fitted to endure any serious surgical undertaking, which must of course be borne in mind when this operation is suggested. The



PROSTATECTOMY.

A horseshoe shaped incision is shown with the two branches opposite the tuber ischii. The flap is drawn backward by a vaginal speculum (d); the wound is held open laterally by the retractors (ee); the urethra is seen deep in the wound anteriorly at (c); the prostate gland (b) is drawn downward by means of the cat's-paw retractor (a).

facts which are in favor of this operation in those whose general condition is not good are:

1. That the patient will be relieved of pain.
2. The drainage of the bladder which follows the operation relieves the urinary obstruction and at the same time prevents further septic absorption from residual urine.
3. The bladder is accessible to irrigation after this operation, so that any septic material which may be secreted from its walls can be frequently washed away.

4. The patient is not exposed to the likelihood of infection in the future, which is almost inevitable if he is compelled to resort to the daily use of a catheter for the purpose of evacuating the bladder.

Preliminary treatment for prostatectomy. In cases in which there has been long-continued obstruction to the passage of the urine as a result of the enlarged prostate gland it is important that preliminary treatment should be instituted. This treatment should consist of the administration of antiseptics such as urotropin in doses of from five to fifteen grains in half a pint of hot water, preferably distilled water, once every six to eight hours for a number of days, or the use of five grains of quinine with half a pint of hot water every six hours for a number of days. The bladder should be irrigated with a solution of 1 to 2,000 permanganate of potash in water. This should be entirely withdrawn, and then a quantity of saturated solution of boric acid in water, equal to one-half of the residual urine, should be left in the bladder. The bladder should be emptied and irrigated from two to four times a day for several days previous to the operation. In severe cases in which it is difficult to catheterize, it is well to permit the bladder to become thoroughly distended, then to insert a large trocar just above the pubis, but stop the outer opening of this trocar with the finger and to insert through the canula of the trocar a retention catheter and then to withdraw the canula and leave the catheter in place. The bladder should be irrigated two to four times each day through this retention catheter as described above, the same amount of boric acid solution being left in place each time. In place of the trocar and retention catheter, the very ingenious apparatus devised by Professor Rodman may be used.

Of late we have usually made a suprapubic cystotomy under local anethesia with novocaine, making an opening in the bladder only just large enough to insert the smaller one of the double tube previously illustrated, and fastening this in place by suturing the outer tube by means of a few catgut sutures. By using this double tube, there is no danger of the inner tube becoming plugged because of a protruding suture or pin into its lumen. Moreover, the outer tube stiffens the inner one so that it is less likely to be shut off by kink. By attaching a drainage tube to the distal end of this rubber tube and passing it over the edge of the bed into a bottle, the patient can be kept perfectly dry.

If the bladder contains much mucus, it is advantageous to irrigate with boric acid solution several times daily. If the patient is given large quantities of distilled water to drink, as much as half a pint every half hour, or if he is given considerable quantities of watermelon to eat, the urine usually becomes perfectly clear and the bladder walls improve with great rapidity, so that after one to two weeks it is safe to perform the prostatectomy.

It remains now to reduce to the minimum the amount of traumatism required for the removal of the enlarged prostate gland. We believe that the operation herewith described fills this requirement.

It is important that patients about to undergo this operation should be carefully prepared in the manner described in connection with suprapubic cystotomy. These cases are almost all chronic in character when they reach the hands of the surgeon; consequently a few weeks spent in securing as aseptic a condition of their bladders as possible is not of much importance to them. It is not so much of a hardship to a man to postpone his relief for a few weeks, after he has suffered for a long time, as it would be if his suffering were acute, and we believe that success depends to a very large extent upon the careful preparatory treatment.

Technique. Before beginning the operation, the bladder is carefully irrigated with one of the mild antiseptic fluids mentioned before in connection with bladder surgery, until the fluid returns perfectly clear. The bladder is

then completely emptied by placing a soft rubber catheter so that it will act as a siphon, and by making pressure upon the bladder above the pubis. Five hundred cc. of saturated boric acid solution is then introduced into the bladder and the soft rubber catheter removed. So far the preparation is the same, without regard to the method of operation to be chosen. During the past few years we have practised the following technique, although our results have not been better than they were when we followed the method to be described later. It has seemed to us, however, as though by following this method we reduced the traumatism to a minimum, and that consequently, our patients showed almost no surgical shock following the operation.

A grooved, steel sound is carefully passed into the urethra until it has fully entered the membranous portion. It is then held by an assistant so that the point of the sound presses against the perineum. An incision is then made 4 cm. in length from a point half way between the scrotum and the anus, downwards and to the patient's left through the wall of the urethra. An old-fashioned lithotomy knife is then passed through this incision so that the button at the end of the knife rests in the groove of the steel sound, and the two of them passed into the bladder simultaneously, care being taken to have the steel sound hug the pubic bone closely. In this manner the posterior wall of the prostatic urethra and the membranous urethra are split throughout their course, the knife and the sound being carried quite into the bladder. The index finger is then introduced into the bladder through this opening and the point of the finger carried down into the prostate gland laterally, precisely as though a supra-pubic prostatectomy were being made. The gland is separated from its capsule throughout. If any points are encountered in which there are shreds which cannot be separated, these are cut with scissors, care being taken to cause as little traumatism to the prostatic urethra as possible.

If there is any hemorrhage, hemostatic forceps are applied and the capsule and wound are tamponed with strips of gauze, care being taken to examine the neck of the gall-bladder for nodules of prostatic tissue which may remain, which will have to be removed separately. Care also should be taken to prevent the edges of the capsule from folding into the bladder. In this way hemorrhage can easily be prevented.

The tampon is removed on the second day, and from the fifth day on the patient receives a daily warm tub bath. Usually the urine passes normally after ten days, sometimes a little earlier and sometimes later. The operation is amazingly simple, representing, in fact, a supra-pubic prostatectomy made through a perineal wound and containing the advantages of supra-pubic and perineal operations. Following this operation it is rarely necessary to make use of irrigation.

For any one who prefers to operate in full view of the field, the operation which has been perfected by Dr. Hugh Young, which we have practised in a great number of cases, gives most excellent results. The preparation is the same as for the operation just described.

In case a preliminary supra-pubic drainage has been applied, the bladder is, of course, not filled with fluid before beginning either this or the previous operation. A steel sound is introduced to the prostatic portion, but not through it, to act as a guide in locating the urethra. A crescent-shaped incision is then made from a point opposite the tuberosity of the ischium on one side to that on the other, the convex portion extending across the perineum, as indicated in the plate. With a finger in the rectum and the steel sound in the urethra one can readily and safely make the dissection forward until the entire lower surface of the prostate gland is exposed, as shown. A few insignificant vessels will be encountered, and from each side there will be one or more divisions of the internal pudic artery, which will bleed freely, but it

can be grasped, either before or after division, with hemostatic forceps and ligated at once in order to leave the space entirely free. All of the smaller vessels may be grasped and also ligated, the important point in this portion of the operation being the complete, careful exposure of the prostate gland. A sharp-toothed cat's-paw retractor is then caught in one lobe of the gland and the latter drawn downward. With a sharp scalpel the capsule of the other lobe is then incised deeply, care being taken not to approach the middle portion of the gland. A second retractor of the same kind is then inserted into the lobe which has just been incised, and the gland kept drawn down while a second deep incision is made through the capsule of the second lobe. While the gland is still held downwards by means of the cat's-paw retractor, a finger is introduced into the incision which has just been made and one lobe of the gland freed from its capsule, regard being taken not to approach the median portion. The retractor is then again changed to the other lobe, and the second lobe is enucleated with the finger, care being again taken not to approach the middle portion until the lobe has been entirely freed. In this manner a considerable amount of annoying hemorrhage is avoided, which comes from the submucous veins at the neck of the bladder. In case the middle lobe is approached at first, these veins are likely to cause a sufficient amount of bleeding to cloud the field of operation.

One finger is now introduced behind each lobe, and by bringing the two fingers together posteriorly, the entire gland can usually be rolled out forward. The anterior attachment is then cut away with scissors, in order not to disturb the anterior portion of the prostatic urethra unnecessarily. A gauze pad is inserted at once to make a slight amount of pressure, which will cause the bleeding to subside readily.

A finger is then introduced into the bladder in order to determine the presence of one or more stones. Occasionally, after a thorough examination of the bladder with a steel sound has failed to determine stones, the digital examination after the removal of the prostate gland will still demonstrate their presence. If stones are found the surgeon should determine whether the opening in the bladder is sufficiently large to permit their extraction. If not then an incision is made posteriorly until the desired size has been obtained. The stones are then removed in the ordinary manner. In ordinary cases all that remains to be done is the introduction of a rubber tube, with numerous small perforations near the end, to the fundus of the bladder. This should be stitched into the angle of the wound. A piece of iodoform gauze may then be tamponed against the remaining portion of the capsule of the prostate gland and permitted to protrude from the wound of the perineum near the point at which the drainage tube issues. A few stitches are then applied to replace the flap.

We believe that it is best not to suture the flap too tightly, because there will be considerable oozing, and if there is a sufficient amount of space for drainage to take place the patient will be saved the possibility of the accumulation of wound secretion. If the bladder has been severely infected we believe it is better to introduce two drainage tubes a little smaller in size to the fundus of the bladder so that irrigation may be accomplished by injecting the irrigating fluid through one tube and permitting it to escape through the other after the operation. In case there should be considerable hemorrhage from the capsule—which, however, is not common—this may be controlled by the application of a few hemostatic forceps, which are permitted to protrude through the wound, and which may be removed after twelve or twenty-four hours with safety. If there is much oozing the space may be tamponed with sufficient iodoform gauze to overcome it, but it does not frequently happen that the tissues require this form of tamponing.

After-treatment. The bladder should be irrigated with one of the various mild antiseptic fluids from one to six times a day, according to the condition of the viscus wall. The iodoform gauze is withdrawn after the second or third day, and from the fifth to the tenth day the rubber drainage tube is removed. In many cases the patient has no difficulty after this time with evacuating the bladder normally, but if the flow of urine is not normal it is wise to introduce a soft rubber catheter through the urethra into the bladder for a few days. It is well to remove it every second or third day to see whether the normal conditions have been established, and if they have not, the catheter may be replaced. During this period it is well to give some mild antiseptic internally and to give the patient large quantities of pure water, in order to dilute the urine. It is well to encourage him to sit up the second or third day after the operation, and to get out of bed as soon as possible, because men at this age do not bear confinement very well.

Prognosis. Bearing in mind the condition of these patients, aside from that of the prostate gland, they withstand this operation remarkably well, and the difference in the comfort of the patient and the improvement in his general condition is very marked. In many cases the free drainage seems to improve the function of the kidneys decidedly, so that after a few months a marked albuminuria may almost entirely disappear. The fact that a constant source of septic infection has been removed is of very great importance to the general health of the patient. We believe this operation adds many years to the lives of these sufferers.

Complications. Occasionally it will be found that the existing adhesions prevent the enucleation of any considerable portion of the prostate gland, and that in order to remove it in the manner just described it will be necessary to produce too severe a traumatism; consequently if it is found impossible to enucleate the lobes of the prostate as described, the following method should be substituted:

The operation is performed as described above to the point of enucleation. This is attempted, but if it proves unsuccessful, the sharp-toothed cat's-paw retractor is applied to one lobe, and the substance of the gland removed piecemeal with cutting forceps. The extent to which it has to be removed can easily be determined by inserting the finger into the field of operation from time to time. The operation is more tedious than enucleation, but much safer than in cases in which enucleation cannot be readily accomplished. The drainage of the bladder and the after-treatment are the same as described before.

PROSTATOTOMY

This operation is performed for the relief of abscess of the prostate gland. In young individuals with an infection of the gland, due to specific urethritis, it is often found that the gland is filled with multiple abscesses, which will keep the patient in a slightly septic condition for a long time. This infection may progress to form larger abscesses, but these usually have for their exciting cause the introduction of steel sounds or bougies. The abscess may increase in size to such an extent as to produce a swelling in the region of the perineum, or it may produce a fluctuating tumor in the rectum. This is accompanied by severe pains and symptoms of acute suppuration. A large abscess that causes swelling in the region of the perineum should be opened through a perineal section, being careful not to injure either the rectum or the urethra. It is well to make the incision quite into the prostate gland, to curette away the infectious material, and tampon the cavity with iodoform gauze. If the fluctuation can be discovered by digital examination through the rectum, the

incision just described may be used, or the swelling in the rectum may be exposed by the use of retractors and the abscess opened into the rectum by the use of the actual cautery. In this event, the opening should be made large enough to insure permanent drainage. The opening will increase in size if it has been made by the cautery, because the eschar which is formed throughout the circumference of the opening will fall off as healing progresses, and thus increase this aperture.

Much has been said against the opening of prostatic abscesses into the rectum for fear of infection. If the wound has been made as just described, and if the patient has received proper preliminary treatment, consisting in the administration of two ounces of castor oil for two successive days previous to the operation, with thorough repeated flushings of the bowel before the operation, and if the operation is followed by proper after-treatment, consisting in the administration of a saline laxative daily and thorough flushing after the evacuation of the bowels, then, according to our experience, the results will be perfectly satisfactory. It is quite different if the abscess is simply incised, especially if the preliminary and after-treatment are not carried out with care.

In the presence of multiple small abscesses of the prostate gland, resulting from repeated infections from gonorrheal urethritis, the gland is exposed as in the operation described for perineal prostatectomy. Then it is drawn down and a deep incision made transversely across each lobe of the prostate, and this is carefully tamponed with iodoform gauze. A small rubber drainage tube is introduced to each lobe of the gland, but not into it, and the wound closed with sutures, with the exception of the two lower angles through which the rubber drainage tube and the iodoform gauze issue.

Prognosis. This operation may result in the complete relief of the patient, especially if he has not the misfortune of acquiring a further gonorrheal urethritis. In many cases, however, the recovery is not permanent, and it will be necessary to perform a prostatectomy in order to give permanent relief.

EPIDIDYMECTOMY

In a majority of cases of tuberculosis of the testicles they are involved secondarily, the primary tuberculosis being in the epididymis, and in many cases in which the testicle is supposed to be tuberculous a careful examination will reveal the fact that the disease is still confined to the epididymis. If this is the case, it is, of course, not necessary to disturb the testicle during the operation, which should simply consist in making a wedge-shaped excision of the epididymis, together with the vas deferens, which is usually involved, and to close the defect with fine catgut sutures. Even if there is a moderate infection of the testicle, a conical excision of the diseased area may be made when the epididymis is removed, and the defect closed with buried catgut sutures. It is only in case of multiple tubercular foci in the testicle, in which it seems impossible to preserve any portion of the organ, in which the multiple puncture with the actual cautery is indicated, because with this method it is possible to preserve a remnant of the organ, even if apparently the entire gland has been destroyed by the tuberculosis.

It is plain that a wound made in this manner cannot heal so quickly as a clean cut one, but the patient is very willing to undergo the necessary annoyance in order to secure the resulting benefit.

The cicatricial tissue which develops as a result of the cauterization seems to do much to prevent the further destruction of the organ by tuberculosis.

If the vas deferens is involved in the tuberculous process it should be

excised. It is not difficult to follow this structure to a point near the bladder by slowly drawing it up into the wound and freeing it from the surrounding tissues by pressure with a moist gauze pad. The external incision may be carried to a point just outside the external abdominal ring. The diseased portion of the vas deferens is somewhat uneven and nodular. It is well to remove the structure to a point some distance beyond the portion that is diseased. In order not to have the vas severed too near the diseased portion it is well to make the dissection very slowly, and then place a pair of hemostatic forceps at the point where it is desired to sever the structure, to apply a ligature at this point and then cut just proximally to the ligature. If the seminal vesicles are left in place, and also the testicles, the patient's sexual life will not be disturbed in the least by this operation, even if both vasa deferencia are removed. This fact is important in connection with this operation when performed for the purpose of securing sterility of the male for sociological reasons.

It has been suggested to perform vasectomy for the sterilization of habitual criminals, epileptics, idiots and other degenerates for the protection of the community.

In this it is not necessary to make so extensive an operation. The skin over the vas deferens may be anesthetized by the injection of a one per cent. solution of cocaine, injected also about the vas, which is brought out through an incision two cm. long; it is ligated twice at a distance of one cm. apart and then severed. The wound is closed with one or two fine catgut sutures and the operation repeated on the opposite side.

The operation is justified by the fact that the community gains enormously while the individual loses nothing. He is not exposed to any risk, suffers no pain and is not inconvenienced in any other way except that parentage is prevented, which in these classes is never of any harm to the individual.

UNITING OF VAS DEFERENS ACCIDENTALLY SEVERED

In case a vas deferens is accidentally severed during the progress of any operation it may be united by passing two sutures of fine double chromic catgut from without into the lumen of one segment, then into the lumen of the other segment, then out through its wall and tying loosely one on each side, and then applying a few sutures to the edges of the vas.

The catgut in the lumen acts as a splint and secures a continuous passage through the vas.

ABSCESS OF THE SEMINAL VESICLES

In many cases the infection is limited to the seminal vesicles. This may be unilateral, or it may affect both sides. If the infection has become chronic nothing short of surgical treatment will give permanent relief.

Technique. The same operation must be performed that has just been described as prostatotomy, differing in that the infected vesicle is located with the finger in the rectum, and that it is carefully and thoroughly removed with a moderately sharp curette. The space is then drained as in prostatotomy.

CASTRATION

This operation is indicated for the relief of malignant disease of the testicle, for gangrene, or for traumatism, which would inevitably result in gangrene of the organ, for destructive suppuration, and for very extensive unilateral tuberculosis.

If tuberculosis occurs in both organs simultaneously, or in the remaining organ after the other has been removed for any reason, we have never found it necessary to perform this operation, but have substituted the destruction of the diseased portion by means of the actual cautery. Even in cases in which only a very slight amount of the tissue may be preserved we have found this of great value to the patient. This is true even in cases in which it was necessary to remove the epididymis, together with the vas deferens. So long as it was possible to preserve the seminal vesicles there has been no mental depression on account of the partial destruction of the testes with the actual cautery, together with the removal of the vas deferens on both sides. It is quite different in case of double castration in patients too young to have passed beyond the virile period normally. Double castration, in our experience, has resulted in permanent relief from urinary obstruction due to hypertrophy of the prostate gland in about fifty per cent. of all cases in which we have made use of this method. There is, however, no definite guide that will indicate which cases are likely to be benefited. Moreover, the operation results in a deformity which is very repulsive to many patients, even though past the virile stage.

It seems as though this method should receive definite recognition, but since perineal prostatectomy has been so much simplified, and its safety so greatly enhanced, it appears doubtful whether castration for the relief of prostatic hypertrophy will continue to be employed to any great extent.

TUMORS OF THE TESTICLE

The most common forms of tumor of the testicle are sarcoma, enchondroma and teratoma. All other forms may occur, but are not common. Tumors should be differentiated from gumma, inflammatory swelling, hydrocele with an unusually tense sac, or a sac which has undergone calcareous degeneration, scrotal hernia with incarcerated omentum, tuberculosis of the testicle and epididymis and simple hyperplasia of the testicle.

The most common error occurs in connection with gumma of the testicle, which is not a very unusual condition. It is frequently necessary to place the patient under vigorous antisyphilitic treatment for a few weeks in order to positively clear up the diagnosis. It seems wise in all of these cases to test the patient carefully with salvarsan before making a positive diagnosis of a malignant growth, as this remedy acts so promptly that even if malignancy is present the patient will lose little because of the delay. Tuberculosis can usually be eliminated more easily because of the nodular condition of the swelling and the tendency to breaking down of portions. There is usually also a tubercular history, and the progress of the disease is relatively slow.

The differentiation between hernia and hydrocele has been discussed in connection with these subjects.

Technique. An incision is made through the skin from the external abdominal ring downward to a point near the lower edge of the scrotum; then the entire organ, together with the tunica vaginalis, is enucleated. A pair of heavy clamp forceps is applied just outside of the external abdominal ring, then the tissues of the cord are dissected out in the inguinal canal. If the tumor is quite advanced, the incision in the skin may be carried to a point opposite the internal abdominal ring, and may be carried through the deep fascia and the fascia of the external oblique abdominal muscle, exposing the tissues of the cord throughout the entire distance of the inguinal canal. In this case the tissues of the cord are dissected out to this point.

The vas deferens is then separated from the remaining tissues of the cord, ligated with catgut, cut and permitted to retract within the internal abdom-

inal ring. The remaining structures of the cord are then separated and the various larger vessels ligated and cut separately and successively permitted to retract beyond the internal abdominal ring. Then the remaining portion of the cord is ligated en masse and cut. In this manner one may easily guard against secondary hemorrhage. All bleeding points are carefully caught and ligated. A small drain is inserted in the lower angle of the wound in order to prevent the accumulation of serum from the large surface. The wound is then sutured and an ordinary dressing applied and held in place, preferably by a properly constructed suspensory bandage.

If the malignant growth has invaded the skin, or the other side of the scrotum, the same should be entirely removed, provided it seems likely that the disease is still localized. Unfortunately metastases usually occur in these cases before they have advanced to the point of invading the surrounding tissues; hence the prognosis is usually hopeless when this condition is present.

If the operation is performed without unnecessary traumatism, it is usually not followed by any severe degree of shock. In patients advanced in age, however, the shock is sometimes quite considerable, and many surgeons have reported the occurrence of acute melancholia, which, it seemed, was not due to sepsis in some. In young patients this operation very frequently gives rise to mental depression, and should not be employed if there is any possibility of avoiding it.

In some cases the deformity may be corrected by inserting into the scrotum a properly shaped mass of paraffin or a hollow structure composed of celluloid of the same form.

One of these devices seems to be of considerable value to neurotic subjects, and if a patient seems inclined to be neurotic it may be well to make use of this plan at the time of the original operation.

PART IX

SURGERY OF THE FEMALE PELVIS

OVARIAN TUMORS

General history. The early history in cases of ovarian tumors is usually negative, the growth being discovered by accident. Among educated people in the higher classes of society such a tumor is usually discovered during a careful physical examination made by the family physician in the course of some illness of the patient which has no relation to the presence of the tumor. Thorough physical examinations are now so commonly made that in this class of patients the growth is usually discovered before it has advanced to any great size.

It is quite different among patients belonging to the so-called lower classes of society. Among these ovarian tumors are usually not discovered until they have attained considerable size, when the patient discovers the growth herself. In a large majority a history of peritonitis at some time in the past can be established, provided the conditions are favorable for obtaining a perfect history. In many cases the time of such peritonitis is so remote that it becomes necessary to inquire from the parents regarding the patient's sickness during childhood.

The peritonitis of early youth and childhood is usually due to appendicitis or typhoid fever, and occasionally to scarlet fever. Later on in life it is more commonly dependent upon a specific infection through the uterus and tubes, and still later to puerperal infection following childbirth or abortion.

These infections are certain to leave the ovaries covered with connective tissue which would favor the formation of retention cysts in the Graafian follicles.

Variety of cysts. They may be simply retention cysts formed by the distension of Graafian follicles with serum secreted from the lining of these follicles. These may be simple or multiple, and may remain small or they may attain enormous size. The largest one we have encountered weighed eighty-one pounds in a woman weighing seventy pounds after the tumor had been removed. Cysts of this variety have, however, been reported much heavier.

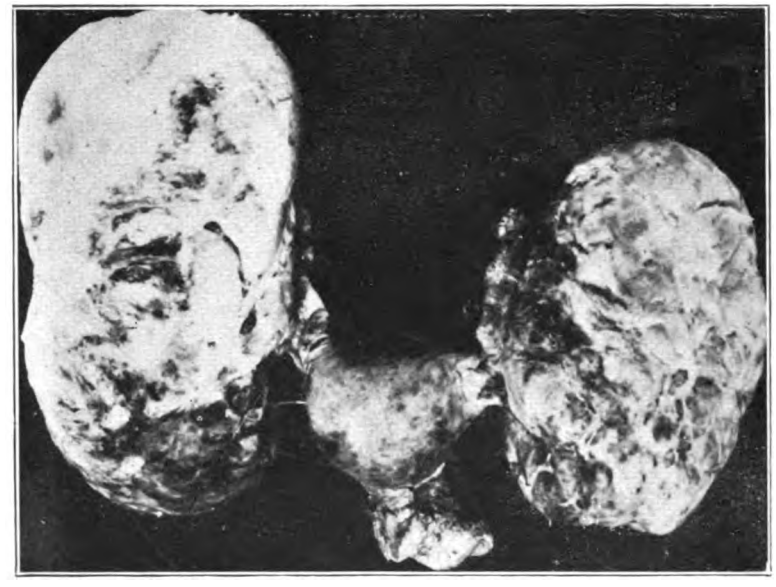
Again the epithelial lining of the Graafian follicle may take upon itself an abnormal development, forming a papilloma or a carcinoma. In this event the cyst contains gelatinous, viscid fluid. The papillomatous or carcinomatous growths may perforate the cyst wall and may infect the peritoneum covering the intestines, or the parietal peritoneum, and then the free peritoneal cavity may contain serous or gelatinous fluid. It frequently happens that this growth invades the surrounding organs and gives rise to complications which are always serious in character ultimately.

Occasionally a portion of the ovary is located in the broad ligament and may in such location give rise to the formation of a cyst known as a cyst of the broad ligament, or intra-ligamentous cyst.

A tumor may consist of a simple retention cyst in one part, and a papillomatous cyst in the remaining portion.

It seems likely that many of these tumors which are primarily simple cysts, later on degenerate into papillomatous cysts, and these in turn into carcinomatous tumors.

Diagnosis. Small ovarian cysts are diagnosed by bimanual examination. They are recognized as more or less spherical masses located in the pelvis. They may lie to the right or left, behind or in front, or above, the uterus. Unless there has been a recent pelvic peritonitis they are likely to be movable and can be separated from the uterus. If the abdominal walls are not very thick fluctation can usually be recognized. Later on when the tumor has attained considerable size it rises in the pelvis and ultimately is forced by its size to occupy the abdominal cavity above the pelvis. Fluctuation can now



SPECIMEN REMOVED IN A CASE OF BILATERAL PAPILLOCYSTADENOMA OF THE OVARIES. TREATMENT—PANHYSTERECTOMY WITH REMOVAL OF BOTH TUMORS.

usually be established across the abdomen. The tumor displaces the intestines, consequently percussion over its most prominent portion gives rise to a dull sound. Above and to either side there is resonance because of the location of the stomach and transverse colon. A change in the position of the patient makes no change in the percussion sounds. It is movable unless strongly adherent on account of peritonitis.

Differential diagnosis. Early in the disease it is most easily confounded with pediculated fibroid tumors of the uterus. The latter are, however, harder, more closely connected with the uterus, and there is with these usually a history of menorrhagia.

Extra-uterine pregnancy may be mistaken for ovarian cyst early in its development, but the absence of menstruation is likely to clear up such a diagnosis.

Pyosalpinx occasionally simulates an adherent ovarian cyst, but its location and the indications of a more or less septic condition usually suffice to determine.

Later on abdominal ascites may be mistaken for an ovarian cyst. An examination of the urine and the heart will establish a nephritic or cardiac cause for the ascites. In the physical examination it will be found that the area of dullness varies with the position of the patient in abdominal ascites, unless this is due to tuberculosis with the presence of adhesions. In ascites the tympany is usually over the most prominent portion of the abdomen while in ovarian cyst the opposite condition obtains, there being an area of dullness over the most prominent portion and tympany over the epigastric and lumbar regions, and a change in position does not greatly change the percussion sounds.

It frequently occurs that the intra-abdominal organs are completely fixed by the presence of adhesions due to tubercular peritonitis, and that the intestines and omentum form a wall above, and the pelvic organs together with the sigmoid flexure of the colon make a dam below, the free ascitic fluid, causing the latter to become encapsulated, as it were, between the abdominal wall in front and these two barriers above and below. In such cases the percussion sounds are quite as constant as in the presence of an ovarian cyst, making the differential diagnosis from the physical examination virtually impossible. The history in such cases will show that the intra-abdominal accumulation was diffuse during the early part of the disease, but this is not always observed, because the surgeon is not consulted until later. There is also an evening temperature during some part of the attack, but this again is not always observed, and when the patient comes under the observation of the surgeon the temperature is no longer abnormal.

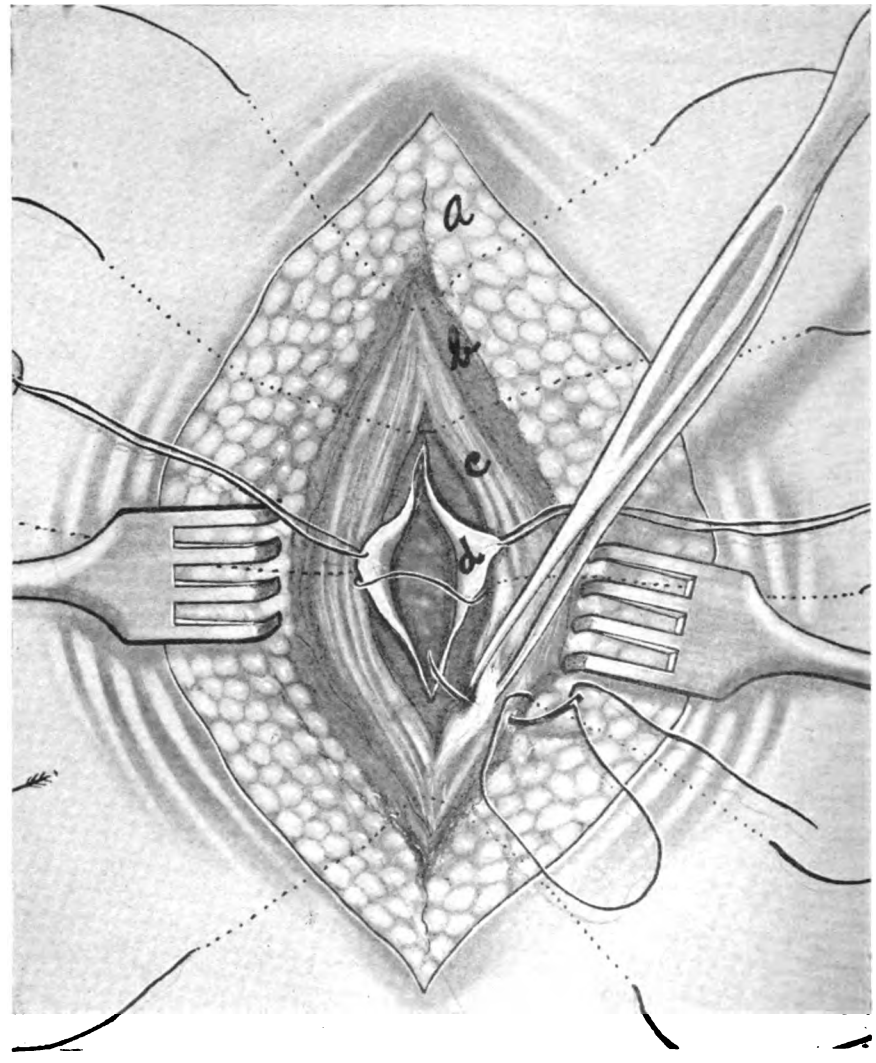
Obesity. Every year we have a number of patients sent with a rather acute circumscribed obesity or lipomatosis of the lower portion of the anterior abdominal wall, with the request to remove an abdominal tumor. Usually a diagnosis of ovarian cyst has been made on account of the presence of pseudo-fluctuation in this mass. The patients are usually obese, but the general condition thereof is slight compared with the local, and unless one's attention has been directly called to this a mistaken diagnosis is most natural. This can be avoided by grasping the mass laterally and lifting it, which will show it to be entirely in the tissues of the abdominal wall and not within the abdominal cavity.

Hydronephrosis. A hydronephrosis is not uncommonly associated with movable kidney, and this mobility may be so excessive as to permit the kidney to visit almost every portion of the abdominal cavity, and, in fact, it may be so movable that it can be palpated in the pelvis, in which event it may be mistaken for an ovarian cyst. This condition is, however, uncommon. It usually begins in the region of the right kidney; there is irregularity in the size of the tumor, and the decrease in its size is associated with the free evacuation of urine. The tumor can be replaced in the right hypochondriac region, and when thus replaced the alteration just spoken of is liable to occur, because this disposes of the acute flexion of the ureter. There are, however, some cases in which it will, undoubtedly, be impossible to make a positive differential diagnosis.

Other simulating conditions. A movable spleen, or liver, has occasionally been mistaken for an ovarian cyst. This is also true of cysts of the pancreas. Very rarely a greatly distended gall bladder may be exceedingly movable, in fact, quite as movable as a hydronephrosis, and in such instance it may be mistaken for an ovarian cyst.

These errors in diagnosis are much more common in patients with thick abdominal walls. The fluctuation which is due to the fat in the abdominal wall frequently causes an error of diagnosis by transmitting the sensation of fluctuation to solid masses, such as the liver or the spleen.

Occasionally an ovarian cyst has a pedicle sufficiently long to permit the tumor to be carried to any part of the abdominal cavity, and then it is likely to be mistaken for a tumor connected with some organ in whose vicinity it happens to be first discovered. In one instance we encountered a carcinoma



ABDOMINAL INCISION THROUGH THE LINEA ALBA BETWEEN THE UMBILICUS AND THE PUBIS.

The deep silkworm gut sutures being in place; (a) subcutaneous fat; (b) deep fascia composed of the aponeurosis of the internal and external oblique abdominal muscles; (c) the rectus abdominis muscle; (d) the peritoneum and transversalis fascia.

of the pylorus as large as a fist, which could be moved to every portion of the abdominal cavity and which was first discovered in the right inguinal region, and was mistaken for a cyst of the ovary.

These errors are, of course, quite uncommon, but it is well to bear in mind the possibility of their occurrence.

Ovarian cyst with twisted pedicle. At times an ovarian cyst with a long pedicle may develop to a considerable size without being noticed, until by some chance the pedicle becomes twisted upon itself and the nutrition of the cyst is thus suddenly interrupted. If the blood vessels are entirely occluded the occurrence is likely to be accompanied by severe pain, which may give rise to a diagnosis of appendicitis, rupture of extra-uterine pregnancy, gall stones, or renal calculus passing through the ureter. The abdominal walls are usually so tense after such an happening that it is practically impossible to make a positive diagnosis without the use of general anesthesia, unless the cyst is of appreciable size and the abdominal walls thin. The presence of a tumor will, of course, clear up the differential diagnosis, with the exception of extra-uterine pregnancy, which, however, is characterized by increasing anemia, and within a few hours after the beginning of the attack it is usually possible to palpate the coagulated blood in the cul-de-sac of Douglas by making a vaginal examination. This coagulated blood has a peculiar, doughy feeling, which, when once detected, will be readily remembered.

Distended urinary bladder. One other condition has been mistaken for an ovarian cyst more frequently perhaps than any other, but this is usually the result of carelessness and is practically always cleared up before an attempt is made to remove the cyst by means of an operation, because it is now the universal practice to catheterize the urinary bladder before undertaking an abdominal section. It has frequently happened that a distended urinary bladder has been regarded as an ovarian cyst, but the passage of the catheter invariably clears up this diagnosis; and a surgeon who has once experienced this blunder will recognize it in future cases without the slightest difficulty.

Impacted feces in the cecum or in the sigmoid flexure have been misjudged for ovarian cyst. The free catharsis which is ordinarily employed in the preliminary treatment of these cases is sure to clear up the diagnosis.

Dermoid cysts of the ovary. The ovary may contain a certain amount of epiblastic tissue, such as skin with hair follicles or mucous membrane with embryonic teeth, or these may exist in connection with bone, connective or glandular tissue. These structures may remain in a latent state for a long period of time, and may then begin to develop into what are technically termed dermoid cysts because of the hair and epithelium and teeth which they are likely to contain. Such cysts do not usually develop to any great size. They usually contain more or less hard tissue, such as bone or cartilage, and are consequently prone to give rise to pain on account of pressure. The differential diagnosis of these tumors in no way varies from that in ovarian cysts, and their treatment corresponds to the treatment of the latter; consequently it will not be necessary to give them a separate discussion.

Technique for the removal of ovarian cysts. An incision is made in the median line between the umbilicus and the pubis, from one to three inches in length. When the abdominal cavity has been opened the cyst will present as a bluish-white, shining surface. If the cyst is simple it will be regular and smooth on its surface; if multiple, one is likely to observe the lobes upon its external surface.

If the cyst is simple, it is best to withdraw the fluid from its cavity by means of a large-sized trocar, which is plunged into it, an assistant pressing the abdominal wall gently against the surface of the cyst in order to prevent the accidental escape of any fluid into the free abdominal cavity.

The cystic fluid. The fluid contained in these cysts may vary in color from a perfectly clear, limpid, to a yellow or dark-colored kind. The latter color is usually the result of a hemorrhage into the cavity of the cyst and ordinarily occurs in those which have been subjected to some form of trau-

matism, such as a blow upon the abdomen. Cysts which have previously been tapped frequently contain dark-colored fluid because of some hemorrhage which has taken place into the cavity through the wound made in tapping. Many cysts contain a thick, gelatinous fluid, which, however, is present usually only in case the lining of the cyst has undergone papillomatous degeneration. The substance may be so thick that it cannot be forced through a trocar, and then the abdominal wound will have to be enlarged so that the tumor may be removed entire. This gelatinous fluid often contains cells which may give rise to the formation of secondary growths upon the peritoneal surfaces, consequently it is wise not to permit any of it to get into the free peritoneal cavity.

The clear fluid contained in ovarian cysts is sterile and harmless, and its introduction into the peritoneal cavity does not result in any harm to the patient.

After the removal of the contents to a sufficient extent to cause the cyst wall to become less tense the same may be grasped in forceps and drawn partly out through the abdominal wound, thus protecting the free peritoneal cavity against the introduction of any fluid. After the cyst has become entirely empty it may be withdrawn through the abdominal wound and its pedicle, consisting of the broad ligament and the Fallopian tube, may be transfixed and ligated with catgut or fine silk, and then the tumor may be cut away, care being taken to leave a sufficient amount of pedicle beyond the ligature to prevent slipping.

Throughout the operation there should be as little unnecessary disturbance of the tissues as possible.

The stump which is left after cutting away the tumor may be covered with peritoneum by means of a few catgut stitches. It is supposed that this will prevent the forming of adhesions with the intestines, but we believe that after an aseptic operation, in which no traumatism is inflicted upon any of the surrounding tissues, such adhesions practically never occur even if the stump is not covered with peritoneum; while they do occur, notwithstanding this covering, provided the operation is septic or traumatism has been caused to the tissues.

If the cyst is multiple, composed of many small cysts, the trocar may be carried from one to the other of these without being withdrawn from the original puncture, provided these separate cysts are large enough to make such practice feasible. If the cysts are too small it is better to enlarge the abdominal wound sufficiently to permit the removal of the tumor *in toto*. This should also be done in case of a papillomatous cyst, or one containing fluid too thick to be forced out through the trocar. The pedicle of such cysts should be tied and the tumor removed in the manner described for the removal of simple cysts.

It is wise always to examine the opposite ovary at the time of operation, because it frequently happens that the second ovary contains a small cyst which, if left undisturbed, will enlarge and require a second abdominal section. Should the fellow ovary contain cysts of any size in a patient over forty years of age, it is wise to remove the entire organ, together with the Fallopian tube, according to the method described. In a younger patient it is usually better to leave at least one-fourth or one-half of the ovary, making a conical excision of the diseased portion and closing the surface caused by this excision by means of fine catgut stitches. This will insure the normal functions of the ovary, which is of great importance to a young patient.

It is well in these cases to examine the vermiform appendix, because remnants of disease may exist in this organ indicating its removal, which

can be accomplished without danger to the patient, according to the methods described in the section devoted to appendicitis.

The abdominal wound is closed in the usual manner, care being taken to unite corresponding layers.

It is our practice to split the inner fascia of the rectus abdominis muscle on each side and to unite the wound by inserting deep silk-worm gut sutures grasping the layers down to the transversalis fascia, and then applying a separate row of continuous catgut sutures to the peritoneum and transversalis fascia, uniting the recti muscles with a few interrupted catgut sutures; then uniting the deep fascia, the aponeurosis of the external and internal oblique muscles, by means of a continuous catgut suture; then tying the silk-worm gut sutures and applying a row of coaptation stitches to the skin, as illustrated in suture of the abdominal wound elsewhere herein.

Complications. The most common complication of ovarian cysts affecting the method of operation is the presence of adhesions. These may exist between the ovarian cyst and any one or more of the intra-abdominal organs. The most common adhesions are to the omentum, the anterior abdominal wall, and to the intestines. It does not matter to what portion an ovarian cyst may be adherent, it is always wise to *expose* the adhesion before an attempt is made to *dispose* of it, because although it may occasionally become necessary to lengthen the abdominal incision for this purpose, still this is of slight importance as compared to the benefit the patient derives from having this portion of the operation performed in plain sight. These adhesions frequently contain very large veins and their injury results in a great loss of blood, which is in itself undesirable and complicates the operation by covering the tissues so that they can be recognized with less ease. It is usually best to grasp long adhesions between two pairs of forceps, to cut between these, and to ligate the portion which is not connected with the ureters, and then drop the adhesions into the abdominal cavity. If the adhesion is to the intestine or other abdominal organ it is usually possible to select a point at which these tissues can readily be separated from each other, because there seems to be a union between the peritoneal surfaces which is not firm and can easily be disturbed if one succeeds in finding the point of cleavage. It is well to cover at once with peritoneum any abraded surface which is caused by this separation, so as to prevent future adhesions. This is especially important if the abraded surface is on the intestine. If this precaution is not observed a perforation may readily occur.

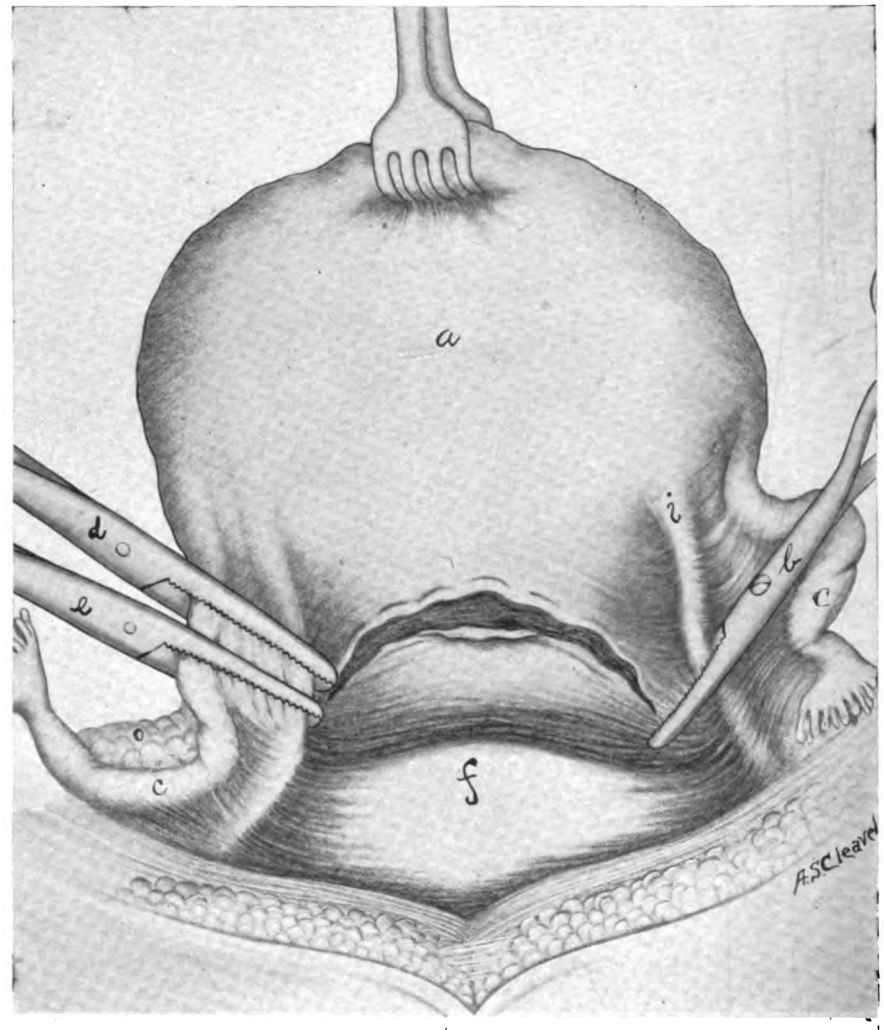
ABDOMINAL HYSTERECTOMY

Principles. The removal of the uterus is in itself one of the simplest and safest abdominal operations in cases in which the condition for which the operation is performed is not connected with troublesome complications. The success of the operation depends upon the appreciation of a few exceedingly simple facts.

In this operation, as in every other abdominal one, the first principle is, of course, the prevention of infection. This may be accomplished very easily, as the only source of infection connected with the operation itself is the uterine canal, and infection from this may easily be avoided with care.

The next important point to be observed is the control of hemorrhage. The uterus is supplied with blood by two small arteries on each side; the ovarian approaching it through the upper part of the broad ligament on each side, and the uterine artery approaching it from each side lower down. These vessels are ordinarily not larger than a good-sized knitting needle, and are consequently of no importance, provided they are recognized and

carefully ligated. The method to be employed for the control of hemorrhage will depend upon the choice of plan for removal; with the uterus, the Fallopian tubes and ovaries, which is always indicated in patients over forty years of age; or the removal of the uterus without the ovaries and tubes,



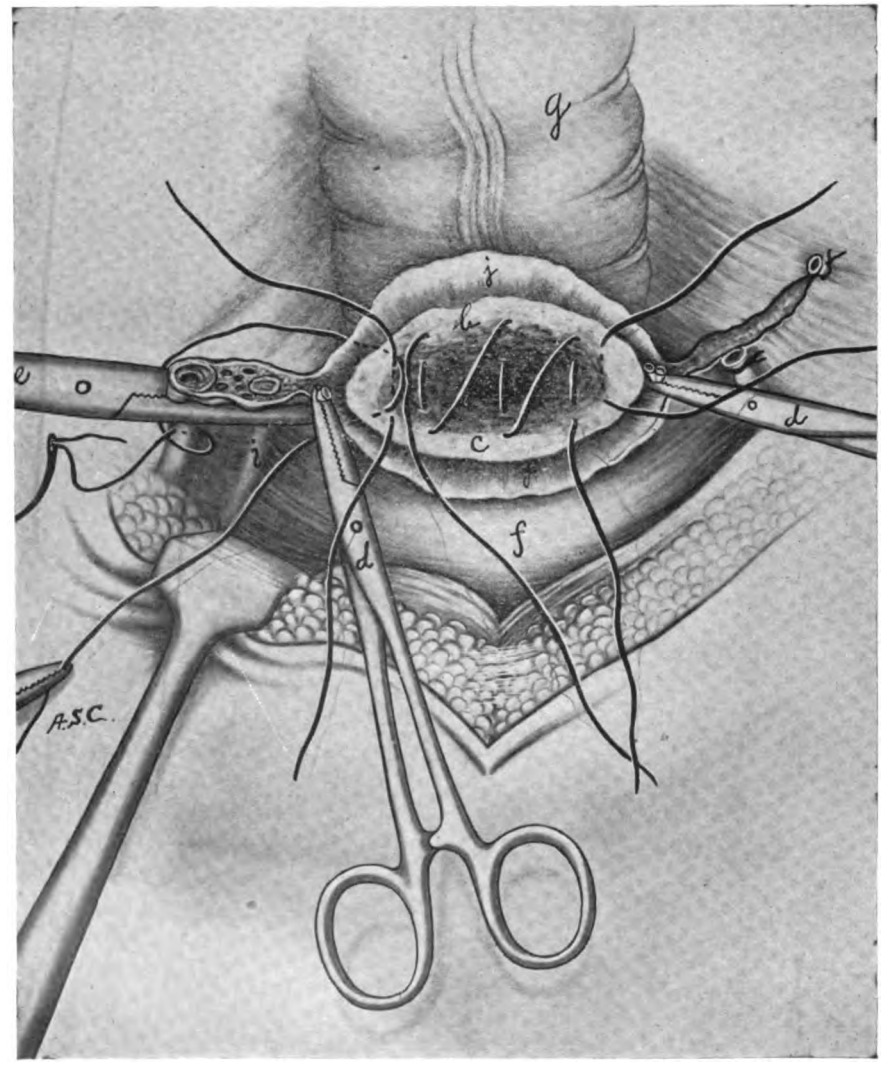
ABDOMINAL HYSTERECTOMY.

a uterus; *b* forceps on broad ligament; *c* Fallopian tube; *d* forceps on uterine side of broad ligament; *e* forceps on ovarian side of broad ligament; *f* bladder; *i* round ligament; *o* ovary.

indicated in younger patients in whom these organs in themselves are not diseased.

Technique. If the ovaries and tubes are to be removed with the uterus, two pairs of long-jawed, strong hemostatic forceps should be applied to the broad ligament, side by side, just externally to the ovary. They should extend parallel to each other with a space of one-half to three-fourths of an inch between

them. The points of these forceps should extend to the body of the uterus. This should be done alike on both sides; then the tissues between these forceps is severed and the uterus, ovaries and tubes, grasped by the two pairs of forceps which are nearest together, can be elevated. The broad ligament

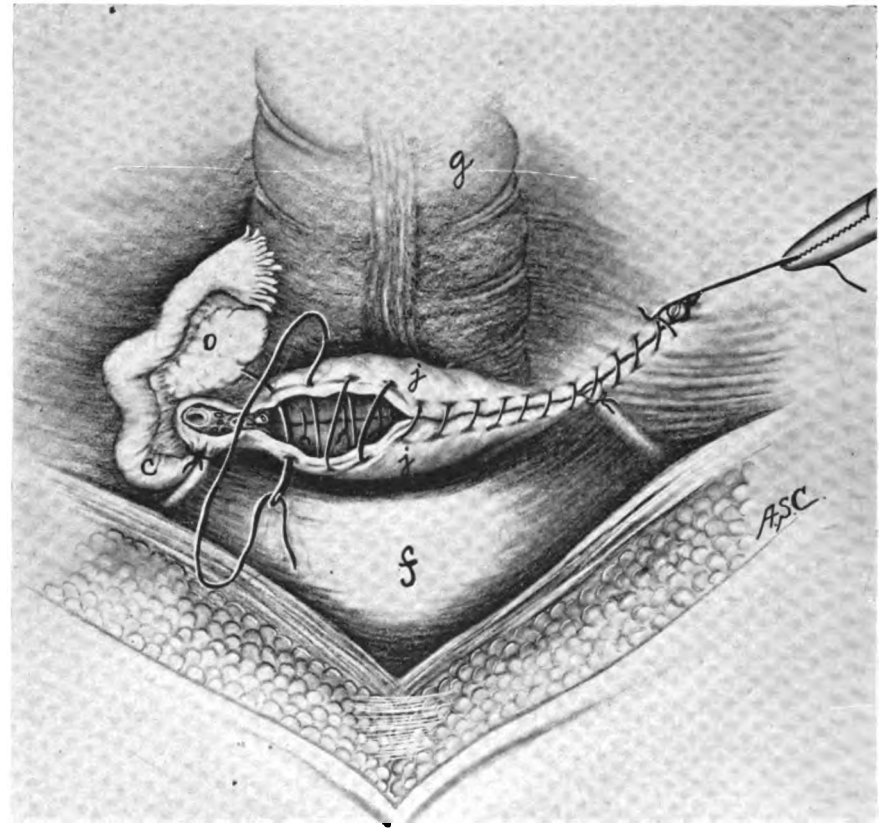


ABDOMINAL HYSTERECTOMY.

b posterior flap of uterine stump; *c* anterior flap of uterine stump; *d* forceps on uterine artery; *e* forceps on broad ligament; *f* bladder; *i* round ligament; *j* peritoneal flap for covering stump of uterus; *g* colon. The suture grasping tissues *b* and *c* should be peritoneal flap *f* instead.

is then severed farther down toward the cervix, until the uterine artery is exposed. This is grasped by a separate pair of forceps on each side; then the peritoneal flap is cut from the anterior surface of the uterus and dissected downwards until a point opposite the internal os is approached. The uterus is then cut away by means of a conical incision. This leaves the mucous

membrane lining the cervix at the bottom of a conical space. It is necessary to exercise great care in cutting down upon the uterine arteries in order to approach them on each side of the body of the uterus after they have escaped from the broad ligaments. If this precaution is not taken there is danger



ABDOMINAL HYSTERECTOMY.

b suture closing in entire surface with peritoneum; *c* Fallopian tube; *f* bladder; *j* flaps of uterus; *g* colon; *o* ovary. To the right the plate shows the ovary and tube removed; to the left they have been preserved.

of injuring the ureters, which pass through the broad ligament near this point.

If the operation is performed for the removal of a myomatous uterus great care must be taken in making the anterior peritoneal flap, because it frequently happens that the bladder is carried a considerable distance up over the anterior surface of such a uterus, and if care is not exercised in performing this part of the operation this organ is likely to be injured.

It is necessary to be careful in sponging the surface of the uterine stump not to carry any infectious material in the mucous membrane lining this stump to other portions of the abdominal cavity, thus causing infection. For the same reason it is well to eliminate this remnant of the canal from the operation by applying catgut stitches to unite the sides of the conical cavity which has been formed. It is this part of the operation which should be done with especial care, because most deaths occurring after abdominal hysterectomy are due to gangrene of the uterine stump, which results from a faulty application of the sutures. During the early practice of this operation surgeons were taught to fear hemorrhage following hysterectomy, and consequently most of the older surgeons acquired the habit of tying the sutures applied to the stump so tightly as to make gangrene thereof a very common occurrence. These sutures, and, in fact, all of the sutures uniting the surface in hysterectomy, should be tied just sufficiently firm to bring the surfaces together, but not so firm as to cause pressure-necrosis. (The observation of this precaution in our own practice has reduced the mortality in abdominal hysterectomy to almost nothing.)

During the past few years we have abandoned the plan of suturing the tissues of the uterine stump and have simply covered this stump by applying fine catgut sutures to the peritoneum, thus carefully covering the raw surface of the stump. In this way the danger from pressure necrosis of the part is entirely eliminated and the operation becomes as safe as a simple ovariotomy or appendectomy.

The broad ligament is now transfixed with a catgut or fine silk stitch and ligated on each side, care being taken to apply this ligature so that there is no possibility of slipping. Then a stitch is placed around the uterine artery on each side and tied only just firm enough to prevent hemorrhage. Then it is our practice to apply a separate ligature to the end of the uterine artery grasped by the forceps on each side. This does not seem necessary, but we continue to do this as a result of the old superstition concerning the likelihood of hemorrhage.

The entire wound should now be sutured from side to side, so that every portion is covered with peritoneum. This completes the very simple operation; the four points to be borne in mind being:

1. The avoidance of infection.
2. The protection of the ureters and bladder.
3. The careful control of hemorrhage.
4. And (most important of all) the prevention of gangrene of the stump by avoiding too firm tying of sutures.

In order to prevent this most serious complication we now never pass sutures through the muscle of the uterine stump but simply cover the stump with peritoneum from the loose portion in front which is sutured to the peritoneum on the posterior surface. If the uterine arteries have been ligated as indicated above there is never any danger from hemorrhage and these patients make quite as smooth a recovery as after a simple ovariotomy.

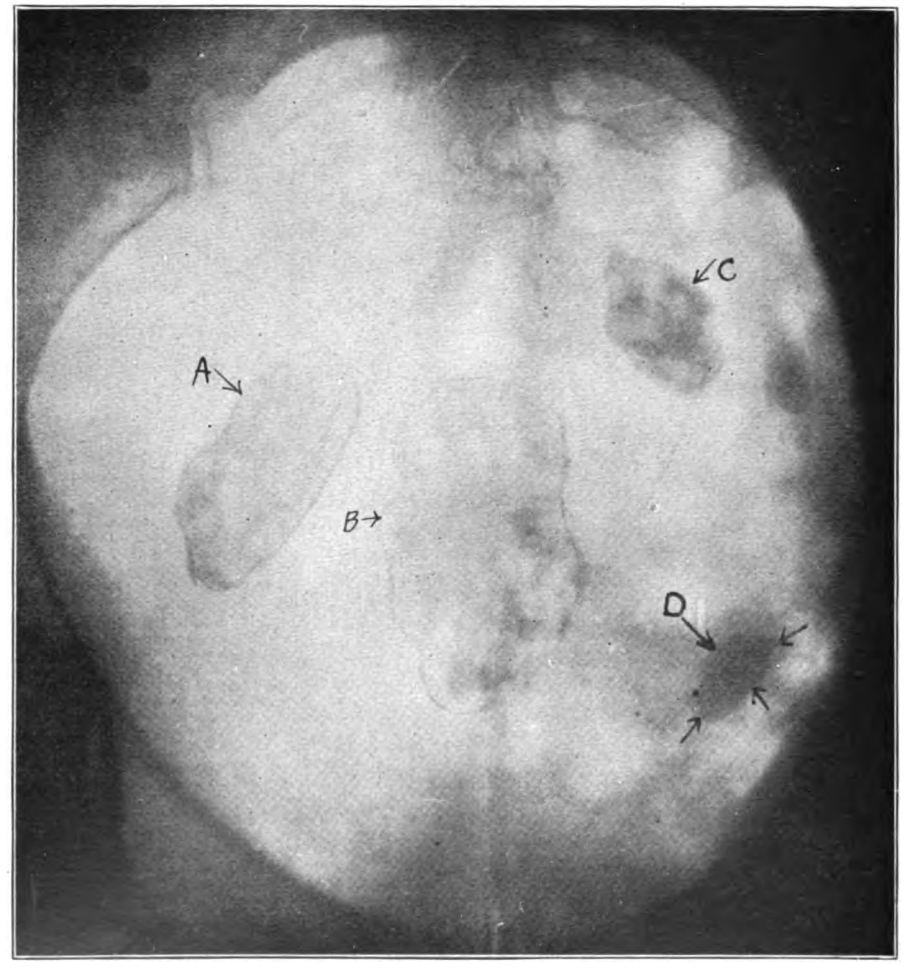
In order to obtain a good floor of the pelvis which will prevent prolapse of the stump we suture the ends of the broad ligaments and those of the round ligament over the stump, thus making a perfect truss for the support of the pelvic floor.

The sutures used are ordinary catgut reinforced by a few of fine chromic catgut for the broad and the round ligaments.

In case it is desirable to remove the ovaries and tubes the operation is done in the same manner, with the exception that the control forceps are applied to the broad ligament directly along the side of the uterus, leaving the ovaries and tubes to the outer side of the other forceps.

SPLITTING OF THE UTERUS

If it is difficult or impossible to apply the forceps to the broad ligaments because of the presence of tumors or adhesions, or both, conditions which occur occasionally, the operation may be greatly facilitated by inserting a strong pair of tenaculum forceps in each horn of the uterus, having an assist-



RADIOGRAPH OF FEMALE PELVIS.

"A" and "B", calcareous myomata of the uterus. "C" calcareous ovary, "D" calcareous iliac lymph gland.

ant make firm traction upon these, and then splitting the uterus longitudinally down to a point opposite the internal os. The tension upon the forceps in the horns of the uterus prevents hemorrhage from the cut surfaces.

Of course, the same precaution must be used against injuring the bladder on the anterior surface of the uterus, if it extends above the normal position, that was mentioned in the operation just described.

When the internal os has been reached a slight lateral incision is made on

one side to a point at which the uterine artery is exposed. The broad ligament, together with the uterine artery, is then grasped from below by means of strong forceps, and the uterus is cut away to the inner side of these forceps. Another pair of tenaculum forceps is inserted in the lower end of the half of the uterus under consideration, and tension made upon this, as well as upon the tenaculum forceps in the horn of the uterus on this side. Care must be taken not to relax upon the other pair of tenaculum forceps for fear of causing a hemorrhage upon the half of the uterus not immediately under consideration.

After the lower end of the uterus has been loosened it is an easy matter to grasp the remaining vessels in the broad ligament by means of clamps, and remove the half of the uterus together with the tumor it may contain. If the Fallopian tube or ovary are also in a pathological condition they can readily be removed with this portion of the uterus. The same steps are taken upon the opposite side.

After the uterus has been removed the vessels are ligated precisely as in the operation which has just been described. The stump of the uterus is disposed of in the same manner, and, in fact, the remainder of the operation is in no way different from that which has just been outlined.

Adhesions. If there are adhesions between the uterus, or the ovaries and tubes, and some other abdominal organs, these must be loosened with great care and all bleeding points properly ligated, and all abraded surfaces carefully covered with peritoneum by means of Lembert sutures. Especial pains must be taken in covering large abrasions upon the small intestine, due to the necessity of loosening extensive adhesions. Whenever possible it is wise to make transverse closures of these abraded surfaces for fear of causing a narrowing of the small intestine, which, however, is not very likely to occur because of the elasticity of the peritoneum. If any abraded surface in the pelvis cannot be covered with peritoneum it is wise to place the sigmoid flexure upon this surface, and, if necessary, to fasten it by a few fine catgut stitches. The abdominal wound is closed in the usual manner.

MYOMECTOMY

Generally speaking it is proper to make a hysterectomy for any cases of fibroid tumor of the uterus in patients of forty years of age or over, in whom this operation seems to require the least amount of traumatism. In younger patients, whenever possible, the excision of fibroid tumors of the uterus, without the removal of the uterus itself, should be practised, even though the operation be connected with greater difficulty and with greater traumatism. It is surprising how easily fibroid tumors may be enucleated from the uterus even when deeply-seated, and if traction is made upon the organ this operation is not connected with much hemorrhage.

If the tumor is in the superior portion of the uterus the transverse incision should be made and the tumor enucleated. Here again the same principle should be applied that has been mentioned in connection with the closure of the stump in abdominal hysterectomy. The space from which the tumor has been removed should be closed by means of fine catgut sutures which are tied just firmly enough to bring the surfaces together, but not sufficiently firm to cause pressure-necrosis. As many rows of these sutures as are required to close the entire cavity should be employed; their number is of no special importance.

When the outer wound in the surface of the uterus is reached it is important to extend the suturing a little beyond each end of the wound, because

this will overcome the troublesome oozing which frequently occurs from the very ends of the incision.

If the uterine cavity is opened during the operation, it should be carefully sponged or curetted and a folded piece of rubber protective tissue passed through the uterine canal into the vagina for the purpose of drainage. In this case the first row of sutures should pass down to, but not through, the mucous membrane, for fear of infecting the deeper tissues in the uterus. The danger of infection from the uterine canal in these cases has been greatly over-estimated, and we believe that in cases in which there has apparently been such an infection it has resulted from the fact that the sutures which were applied for the purpose of protecting the wound in the uterus were tied too firmly and gave rise to pressure-necrosis. In case a large fibroid has developed in the broad ligament, so that after its removal there remains a large raw surface, this should be covered with peritoneum, but if the uterine cavity has been opened during the operation, or if the rectum or the sigmoid flexure have been disturbed, it is best to insert a small glass drain or a cigarette drain into the angle of the broad ligament next to the uterus and to permit this to pass out of the lower angle of the abdominal wound. It may be removed in two to five days.

PYOSALPINX

Clinical example. This is typical of the disease under consideration. The patient is twenty-three years of age, married fourteen months, and gives the following history:

She suffered from mild attacks of all the contagious diseases of childhood, but experienced no unfavorable after-effects. Menstruation began at the age of fourteen, was regular and painless, and the patient's health was excellent until a short time after her marriage, when she suddenly experienced severe pain in the lower portion of her abdomen. She had previously observed the presence of leucorrhea and a mild attack of cystitis, to which she gave no attention. After remaining quiet for two days, taking hot douches and a cathartic and applying heat to the abdomen, the pain subsided and she was able to be up and about, but since that time she has never felt perfectly strong and well. Her next menstrual period was characterized by severe pain, lasting for two days and leaving her slightly worse than before. She felt feverish during the entire period of menstruation. She has continually grown worse, suffering from severe pain every few days, and during each successive menstrual period having an attack more severe than the preceding. During the past two months she has scarcely recovered from the effects of one attack before experiencing the next. At the time of her marriage she was strong and vigorous and in every way in excellent health.

Present condition. Anemic, somewhat emaciated, having lost twenty pounds during the past year. Her appearance indicates that she has suffered severely. Skin is rough and her color is bad.

Physical examination. All organs, with the exception of the pelvic, are normal. A pelvic examination reveals the presence of severe induration throughout the pelvic floor. In the left broad ligament there is a mass as large as a man's fist. The right broad ligament contains a mass about one-half as large. The cervix of the uterus is enlarged to twice the normal size; it is hard and edematous. Bimanual examination seems to reveal a slight amount of fluctuation in the left side.

Upon rectal examination there is found an indurated area opposite the cul-de-sac of Douglas, which renders this portion of the bowel quite rigid. The patient complains severely of pain during both the rectal and vaginal examinations. Upon bimanual examination the abdominal muscles contract to protect the inflamed tissues underneath.

Diagnosis. The history, as well as the physicial investigation, indicate the presence of an infection involving the uterus, Fallopian tubes and pelvic peritoneum. This is undoubtedly gonorrheal in origin, because of the time of its occurrence, the presence of leucorrhea and cystitis, and the physicial evidences.

Upon inquiry we have determined that the husband suffered from an acute specific urethritis two years ago, from which he recovered after four months, but that he occasionaly noticed a slight amount of secretion after some indiscretion in diet or over-exertion. About one week after his mar-

riage he noticed a slight recurrence of this condition, which, however, disappeared after a few days.

It is likely that the infection advanced slowly through the uterine canal and through the Fallopian tubes and that the fimbriated extremities of the latter organs have become adherent to the ovaries and thus become occluded, and that pus has accumulated in the distended Fallopian tubes.

The patient has received local treatment almost constantly since the beginning of her illness, by means of hot douches, the application of tincture of iodine and nitrate of silver to the uterine canal and the cervix, and by the application of vaginal pads saturated with glycerine and ichthyol; but none of these remedies has been of any permanent benefit.

Medical treatment. During the early part of the disease it is best to make use of non-surgical means.

1st. Because many severe infections of this form recover completely under this treatment and later go through normal pregnancies provided reinfection is avoided.

2nd. Because surgical treatment is exceedingly dangerous during the early portion of the disease, while it is quite safe later on.

3rd. The patient is not exposed to any risk because of the postponement of operation, provided the internal treatment is carried out properly and rest in bed is insisted upon.

The infection affects a relatively small and safe portion of the peritoneal cavity—the pelvic portion. If it is confined to this region the worst possible consequence will be a circumscribed abscess which, from its location, may either become absorbed, or remain encapsulated, or it may rupture into the rectum, the bladder or the vagina. If undisturbed the rupture will practically always take place into the rectum if it occurs at all, which is, of course, the most favorable direction.

The circumscribed infection. Anatomically the arrangement is most perfect for the development of circumscribed abscesses.

If the infection advances slowly the fimbriated extremities of the Fallopian tubes will become adherent to the ovaries or to the floor of the pelvis, and then the infection will be confined to one or to both tubes. It may remain in this position, dilating the tubes until they attain a considerable size, or they may become distended beyond their capacity and rupture and infect the surrounding tissues. In this event adhesions have usually formed before the rupture takes place. These most commonly exist between the tube and the omentum or cecum, or sigmoid flexure of the colon, or some loop of the small intestines, or several or all of these. It is very seldom that an abscess of this kind ruptures into the free peritoneal cavity except as the result of a severe strain or a traumatism.

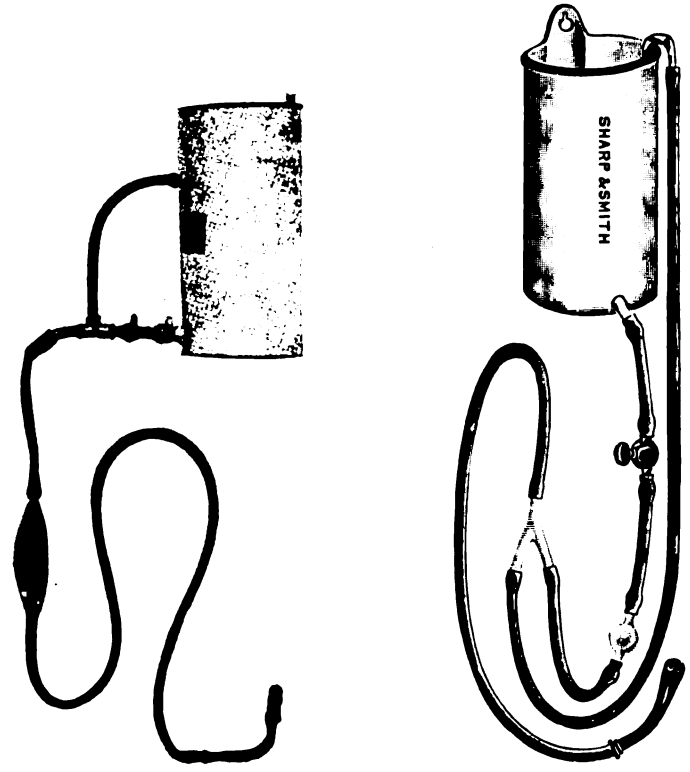
With a circumscribed infection the conditions are very similar to those described with the infection due to perforative or gangrenous appendicitis, and consequently the early treatment should have the same end in view as has the non-surgical treatment of acute appendicitis, namely, the confinement of the infection to the vicinity of the tissues originally involved.

The physiological elimination of the infected area in the condition under consideration is almost perfect because the omentum will apply itself to the surface of the tube, the sigmoid flexure will apply itself above and to the left, and the cecum and appendix to the right. If there is still a small area left it will be occupied by some portion of the small intestine, and as all of the tissues which have been mentioned, except the small intestine, are relatively fixed, the infection is likely to remain circumscribed unless it is carried by the small intestine from its original area to other portions of the peritoneal cavity. This can be prevented by inhibiting peristaltic motion, which,

as has been shown before, may be accomplished by the prohibition of all food and cathartics by mouth and, if necessary, by the addition of the use of opium. If the stomach contains food or mucus this should be removed by gastric lavage.

It should be remembered that where neither food nor cathartics are given by mouth, opiates may be administered either by enemata or hypodermatically with safety, to the patient.

Large, hot, vaginal douches frequently administered are a source of great comfort and are of undoubted benefit to these patients. The douches should



Forms of Irrigation Apparatus Useful in Rectal Feeding, Etc.

be given as hot as they can be borne. The patient may be nourished by the use of nutritive enemata, which have been described herein before.

There is an important advantage in first treating all cases of this class by the method just described, aside from those mentioned early in the consideration of this subject, owing to the fact that the virulence of the micro-organisms causing this infection will be very greatly reduced if the infection is compelled to remain circumscribed; in other words, we make use of the principle of rest in the treatment of this infectious disease the same as we do in the treatment of like conditions in other parts of the body. If this state of rest is continued for a time the infection becomes so thoroughly circumscribed that the pus itself will ultimately destroy all of the micro-organisms which it contains, and when examined will be found perfectly sterile.

An operation performed after the pus has acquired this condition of sterility is of course relatively very much safer than if done while the pus is

still full of living pathogenic micro-organisms. It is likely that in many cases in which it was supposed that a re-infection took place from the pus that existed in a circumscribed abscess, there was in fact a re-infection through the uterus. The occurrence of such re-infection should, of course, be carefully guarded against.

Although a large majority of cases in which there is but a single infection of the Fallopian tubes will recover fully, or to such an extent that it is impossible to determine the presence of any pathological condition by physical examination, there will always be many who have either had repeated infections or have not recovered fully from a single infection, and these cases can be relieved permanently only by surgical operation.

Operative technique. The operative treatment must be planned so that none of the clean portions of the abdominal cavity become infected during operation, so that all of the disease is removed, and so there will be no serious secondary conditions developed as the result of the operation.

To prevent the infection of portions of the peritoneal cavity not involved, it is wise to make the abdominal incision sufficiently long to enable the surgeon to perform the necessary manipulations in sight. In severe cases it is usually best to make the incision from a point an inch below the umbilicus to the pubis. In mild cases it may be considerably shorter. In unusually severe ones it is often best to carry the incision around the umbilicus to the left and a convenient distance above the same.

The operation can be greatly facilitated by placing the patient in the Trendelenburg position, by elevating the foot of the table so that the patient's body rests at an angle of about forty degrees. This causes the intestines to withdraw into the upper portions of the peritoneal cavity, or if they do not take this position by their own weight, the object may be accomplished by pushing the intestines upwards by means of a large, moist, sterile, gauze compress. The intestines should be carefully tamponed away from the seat of the operation, as thus they will not be exposed to infection during the operation, nor to the irritating influence of the air.

The entire operation can now be done without manipulating anything outside of the pelvis, and this portion of the peritoneal cavity is the least sensitive and its manipulation is accompanied by the slightest amount of shock. This is a fact of very great importance, and if borne in mind the patient's suffering may be reduced greatly and her chances of recovery much improved. The further steps of the operation will depend upon the extent of the infection and upon the parts involved, as well as upon the number and firmness of adhesions.

If the Fallopian tubes alone are concerned, forming sausage-shaped bags of pus, the operation will be identical with that described for the removal of ovarian cysts. The broad ligament will be ligated below the mass and a second ligature placed around the Fallopian tube near the uterus and the mass cut away, leaving a sufficient amount of tissue beyond the ligature to prevent slipping. It is well to place a pair of forceps upon the Fallopian tube beyond the point at which this is cut away in order to prevent any leakage from the cut.

Many authorities prefer to excise a conical portion of the uterus together with the end of the Fallopian tube, and to close this by means of sutures. Theoretically such a method seems preferable, but practically there is no difference between the two.

If the adhesions are extensive it is often much easier to place two pairs of forceps upon the Fallopian tube at its point of entrance into the uterus. The forceps should be placed parallel to each other; then the tube cut away between these, which opens the space between the upper and lower fold of

the broad ligament. By applying forceps successively upon the broad ligament from within outward, and cutting between, it is usually possible to enucleate the pus tube without the danger of rupturing it. In many cases the uterus itself seems so thoroughly infected that it may be best to remove it together with the tubes and ovaries. Then the operation described for the removal of the uterus containing fibroid tumors may be employed, great care being taken, of course, to prevent a rupture of the abscess. It is in such cases that the method of splitting the uterus longitudinally is often of especially great value. The remaining steps are the same as those which have been already pointed out.

Here again it is particularly important to exercise care in inspecting the surfaces of the small intestines which have been adherent to the ovaries or tubes, or to the infected uterus, as in loosening these adhesions it sometimes happens that a loop of intestine is perforated, and unless such perforation is carefully closed and the surface covered with peritoneum a fecal fistula is apt to occur and the intestinal contents may cause an infection of the peritoneum, giving rise to a septic peritonitis from which the patient may die.

After all of the diseased tissue has been removed it is wise to cover the abraded surfaces, as far as possible, with portions of the surrounding healthy peritoneum. If this cannot be done the sigmoid flexure should be brought down and placed across this portion of the pelvis, and if there is doubt about this remaining in position it is well to fasten it by means of a few catgut stitches. The omentum should also be brought down to this surface. If the operation has been accomplished without causing a rupture of the abscess the surface should be sponged perfectly dry, the gauze tampons placed for the protection of the surrounding intestines should be removed, and it is well to bring the omentum down over the small intestines so that these do not come in contact with the field of operation, because of the danger of distribution of infectious material by peristaltic motion.

If there is any doubt about the aseptic state of the field of operation it is always best to apply some form of drainage. We have found a curved glass drainage tube, half an inch in diameter, placed within a strand of iodoform gauze behind the stump of the uterus in the cul-de-sac of Douglas, and permitted to protrude through the lower angle of the wound, most satisfactory. This tube can usually be removed on the second day, and the gauze surrounding it two days later, permitting the abdominal wound to close perfectly without danger of the formation of ventral hernia.

If there has been a severe infection it may be necessary to leave the tube in place for a longer period of time.

The abdominal wound is closed down to the drainage tube in the usual manner. In many cases it is simpler and better to puncture the vault of the vagina with a pair of blunt-pointed scissors or forceps and drain the infected area directly into the vagina by means of gauze or cigarette drains, or by combining these with rubber drainage tubes. In some very extensive cases we have combined this method with that just described, draining both through the vagina and through the abdominal wound.

These points then are of marked importance:

1st. Banking away of the non-infected contents of the abdominal cavity.

2d. Manipulation of only the structures contained in the pelvis.

3d. Care to prevent perforation of the intestine.

4th. Covering of all raw surfaces either with peritoneum or with the sigmoid flexure or omentum, or both.

5th. Drainage in cases in which the surgeon is not positive that the field is aseptic, preferably into the vagina.

After-treatment. If these patients bear the administration of small, fre-

Table I Classification of Uterine Carcinomata.

Group I: Cases which were clearly operable after a physical examination.
- Subgroup a: Cases treated with preoperative Radiation and Panhysterectomy.
- Subgroup b: Cases treated with Panhysterectomy and postoperative Radiation
- Subgroup C: Cases treated only with Radiation

Group II: Cases which were doubtfully operable after a physical examination. „Borderline Cases."
- Subgroup a: Cases treated with Radiation and Panhysterectomy.
- Subgroup b: Cases treated only with Radiation.

Group III: Cases in which an operation was absolutely impossible.
- Subgroup a: Cases treated with Radiation and Panhysterectomy.
- Subgroup b: Cases treated with extensive Cauterization and Radiation.
- Subgroup C: Cases treated with Radiation only.

Group IV: Cases so far advanced that all treatment was hopeless. They were subjected to Radiation for purposes of palliation.
- Subgroup a: Cases treated with extensive Cauterization and Radiation.
- Subgroup b: Cases treated only with Radiation.

Group V: Cases that recurred after a Panhysterectomy.

Table II. Total Number of Cases Treated from April 1. 1914 to April 1. 1920

Group	Number	Living	Dead	No Report or Refractory.
Ia.	3	3		
Ib	11	9	2	
Ic	1	1		
Total	15	13	2	
IIa	13	5	5	3
IIb.	9	7	2	
Total	22	12	7	3
IIIa	16	2	10	4
IIIb.	25	4	9	12
IIIc.	41	18	11	12
Total	82	24	30	28
IVa	6	1	1	4
IVb	33	6	16	11
Total	39	7	17	15
V.	50	9	16	25
Grand Total	208	65	72	71

Table III Time elapsed since Treatment in Cases known living or dead of Group I.

Subgroup a.					Subgroup b.					Subgroup C.				
Living		Dead		No Report or Refract.	Living		Dead		No Report or Refract.	Living		Dead		No Report or Refract.
yrs	mths	yrs	mths		yrs	mths	yrs	mths		yrs	mths	yrs	mths	
5	6				5			3		2	7			
4	1				4			4						
2	10				2	7								
					2	7								
					2									
					1	7								
					1	5								
					1	1								
						5								
3					9		2			1				

Table IV. Time elapsed since Treatment in Cases Known living or dead in Group II.

Subgroup a.					Subgroup b.				
Living		Dead		No Report or Refraction	Living		Dead		No Report or Refraction
Yrs	Mths	Yrs	Mths		Yrs	Mths	Yrs	Mths	
5	2	2		3	2	6		1	
3	2	1			2		2	2	
3			2		1	10			
2	1		5		1	8			
1	2	1 sudden				9			
						7			
						3			
Total	5	5		3	7		2		

Table V. Time elapsed since Treatment in Cases Known living or Dead of Group III.

Subgroup a.					Subgroup b.					Subgroup c.				
Living		Dead		No Report or Refract.	Living		Dead		No Report or Refract.	Living		Dead		No Report or Refract.
Yrs	Mths	Yrs	Mths		Yrs	Mths	Yrs	Mths		Yrs	Mths	Yrs	Mths	
	11		3	4	1	2	1	2	12	2	8		8	12
	9		2		3	3	1	8		1	8	2	10	
			5		4			2		1	4		8	
			5		2	6	1	6		1	4		2	
			5					3		1	4	1	4	
			7				2	1		1	2		9	
			4				1	9		1		1	3	
		1	1					6			11	1	3	
			9					10			10		10	
			7								9		2	
											9			
											8			
											6			
											6			
											6			
											4			
											4			
											4			
2		11		4	4		9		12	18		10		12

Table VI. Time elapsed since Treatment in Cases known Living or Dead in Group IV.

Subgroup a.					Subgroup b.				
Living		Dead		No Report or Refraction	Living		Dead		No Report or Refraction
Yrs	Mths	Yrs	Mths		Yrs	Mths	Yrs	Mths	
2	9		1	4		10	4 days		11
						7		4	
						5		2	
						3		5	
						3		5	
						2		7	
								2	
								2	
								2	
							4 days		
								5	
							3 days		
							8 days		
								11	
							6 days		
							6 days		
Total	1		1	4		6		16	11

Table VII. Time elapsed since Treatment in Cases known Living or Dead of Group V.

Living		Dead		No Report or Refraction
Yrs	Mths	Yrs	Mths	
3	9		8	
1	10	1		26
1	4		3	
	10	2	6	
	10		11	
	9	1	7	
	7		6	
	3		3	
	3	2	3	
			8	
			6	
			3	
		1		
			5	
		12 Days		
			2	
Total	9		16	25

quently-repeated draughts of hot water well, such should be given. If this causes nausea or vomiting it is best simply to have the patient's mouth rinsed with hot or cold water and not give anything by mouth for two days. At the end of such time beef-tea or one of the various concentrated predigested foods may be given every two hours in small doses. After two days these patients usually bear hot water well. Rectal feeding is generally somewhat dangerous because of the congestion which follows an extensive operation in the pelvis. The alimentary canal should be perfectly empty before the operation, as a result of the administration of two ounces of castor oil on the previous day. If no further food is given by mouth morphine may safely be administered hypodermatically if necessary, to quiet the pain. Of course, in cases which, for any reason, must be operated during the acute attack no cathartic should be given before the operation, for fear of causing the septic material to be carried from its circumscribed location to distant portions of the abdominal cavity by the production of peristalsis resulting from the cathartic.

If for any reason it seems objectionable to perform an abdominal section in these cases, the uterus, ovaries and tubes may be removed by the vaginal route, to be described later. The objection to this route lies in the fact that the conditions cannot be so perfectly determined and one frequently removes organs which might be saved if the abdominal operation were chosen. It also happens frequently that a diseased vermiform appendix is overlooked.

In the criminal classes we believe this operation is indicated much more commonly than among other patients, because re-infection is almost certain to occur if the uterus is not removed together with the other infected organs. There is an important economic as well as a sociologic responsibility in the surgical treatment of the criminal classes suffering from specific infection of tubes and uterus. In these cases the uterus should always be removed because it is certain to spread infection to others and entail unwarranted expense upon the community for the care of these cases in public institutions.

In all of these patients it is extremely important to leave at least a portion of one ovary so long as the patient has not passed the menopause, as if both ovaries are completely removed in young women the patient is likely to suffer from severe nervous disturbances. These may fortunately be avoided by leaving a portion of one ovary.

TRANSPLANTATION OF THE OVARIES

In many of these cases in which both ovaries have been removed at a previous operation, great benefit may be secured by transplanting a fairly healthy ovary by the following method: It is best to select for a source an ovary which must be removed because of prolapse in a case in which the fellow ovary is quite normal and in which it seems unlikely that any operation short of removal would result in the relief of the patient. This ovary may be preserved in sterile normal salt solution for several days or weeks and may then be transplanted, but it is probably better to make the transplantation directly from one patient to the other.

Technique of operation. An incision ten cm. long is made over the middle of the rectus abdominis muscle. The aponeurosis is split and also the muscle. Its posterior surface is separated from the transversalis fascia. The ovary is laid open by means of a longitudinal incision. The ovary is then placed in the pocket between the muscle and the transversalis fascia, with the raw surface caused by splitting directed toward the muscle. It is held in place by a few fine catgut sutures, then the split in the muscle is sutured, and the aponeurosis and skin wounds are closed and an ordinary dressing applied. If the uterus has not been removed and the patient is young, menstru-

ation may be re-established and the nervous disturbances due to the artificial menopause are likely to disappear.

It is of course important to choose an ovary from a patient who is free from syphilis and tuberculosis. It may be well to test the donor with one of the various tests for tuberculosis and for syphilis in order to be quite safe.

CARCINOMA OF THE UTERUS

Abdominal vs. vaginal hysterectomy. During the past few years there has been much difference of opinion regarding the advisability of treating the various surgical diseases of the pelvic cavity through an abdominal incision, or through a vaginal incision; the general surgeon, as a rule, being more familiar with the abdominal route than with the vaginal, has usually supported the former, while the gynecologist has more commonly advised the vaginal route for the relief of all conditions that could be accomplished through a vaginal incision. The abdominal route has undoubtedly the advantage of enabling the surgeons to expose the pelvic cavity freely, especially since these operations are performed with the patient in the Trendelenburg position, by means of which the intestines can easily be removed from the pelvis, leaving only the uterus and adnexæ, the bladder and the rectum in this cavity. This route also permits the surgeon to examine the appendix, for disease frequently the concomitant of other pelvic troubles; it also enables him to examine the gall bladder and to dispose of adhesions between the omentum or the intestines and the pelvic organs. The vaginal route has the advantage of being safer in the hands of a surgeon who is familiar with this class of operations, the mortality in all forms of operations performed by this route being exceedingly low.

There is the further advantage in the fact that no external scar is produced by this avenue which is of importance to some patients who are exceedingly sensitive. In order to overcome this objection Pfannenstiel introduced the transverse incision for abdominal section, made in the area covered by the pubic hair which will later hide the scar completely.

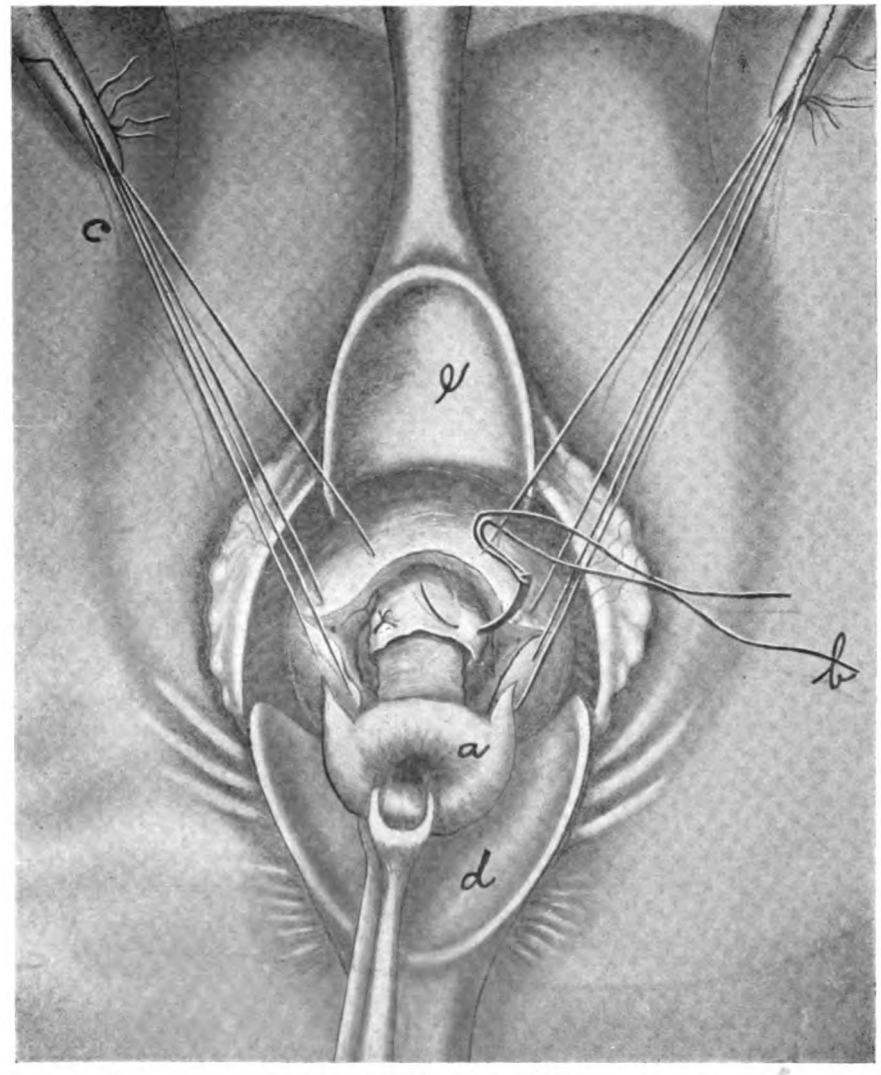
VAGINAL HYSTERECTOMY

This operation is indicated in carcinoma of the uterus so long as this organ is movable and there is no positive evidence of the invasion of any of the surrounding tissues, and no infection of the inguinal lymphatic glands.

Cautery for carcinoma of the cervix. If the organ is no longer movable the patient has lived longer and more comfortably, in our experience, if, instead of removing the uterus we protect the vaginal walls and thoroughly cauterize the entire uterine cavity by introducing cautery irons heated to red heat. The most convenient form of cautery iron for this purpose, according to our observation, is the ordinary soldering iron heated in a tinner's heater, in a coal fire or in the flame of a gas stove. A number of these irons are placed in the flame and are introduced into the cavity of the uterus successively until the entire cavity has become lined with an eschar. An iodoform gauze pad covered with glycerine is then inserted and a retention catheter introduced into the bladder. After the eschar separates the connective tissue which forms during the process of healing contracts the organ and is likely to retard the progress of the disease. Many of these patients improve so much that the surgeon is prone to doubt his diagnosis, and one of our cases, which seemed at the time entirely inoperable and hopeless, lived for a period of nineteen years and died of an intercurrent disease without having had a recurrence of the carcinoma. A number of other cases have lived from three to ten years. Of course, this is not the rule. Most patients have a recurrence within one or two years, to which they succumb.

Importance of early diagnosis. The most important point regarding the treatment of carcinoma of the uterus, however, is early diagnosis and imme-

diate treatment. In order to make an early diagnosis we believe it is important that the surgeon should make a careful examination in every case in which there is the slightest suspicion of malignancy. This is true especially at about the period of the menopause, or after the end of this. In almost every case



VAGINAL HYSTERECTOMY.

The vaginal orifice is held open by means of specula (e) (d). The cervix (a) is loosened from its vaginal attachment by an elliptical incision. The uterine arteries are picked up with a cat-gut suture (b) and tied. Sutures are inserted on either side (c) for the closure of the wound, but left untied until the uterus has been removed.

which has come under our care for treatment, there has been a history of uterine hemorrhages more or less extensive. If these hemorrhages occur in a patient fifty years of age, or over, the physician should recognize the gravity of this symptom. If he temporizes without having satisfied himself positively

regarding the diagnosis, the chances are that by the time the diagnosis is made the case has passed beyond the stage at which surgical intervention could result in permanent benefit.

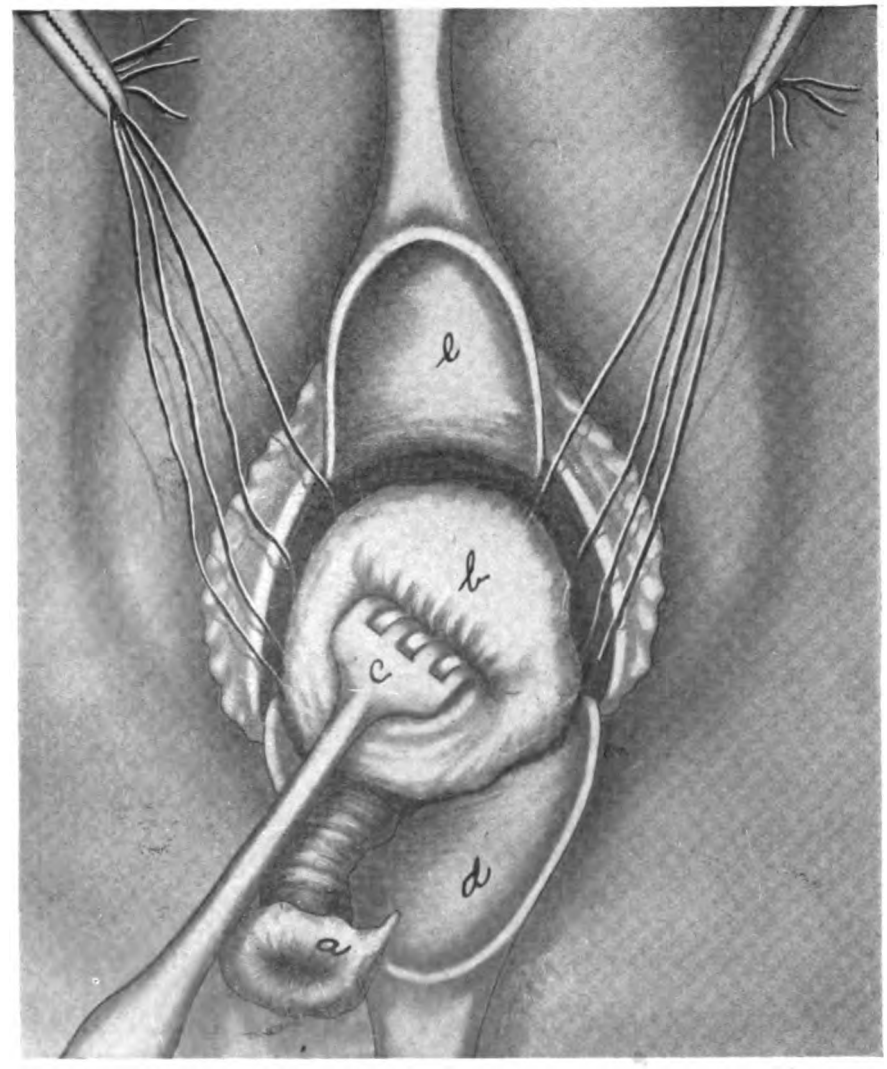
Dangers of diagnostic sections and curettement. If the growth begins in the cervical portion of the uterus, which is its most common origin, then it can be at once discovered upon a digital examination or with the speculum. In case the tissues appear suspicious, with this history and at this age, we believe that a hysterectomy should be performed at once. In many cases in which portions of the malignant growth have been removed for microscopical examination our experience has been that this simple procedure has resulted in the stimulation of the growth to such an extent that even in very recent examples there has been no permanent cure after this method of diagnosis has been employed. We believe that the removal of a portion of tissue for microscopical examination prior to operation should be most strongly condemned. The same is true if hemorrhages occur in patients after the menopause, in whom neither cervical carcinoma nor fibroid of the uterus can be diagnosed by physical examination. In these it has been the practice to do a curettement of the lining of the uterine cavity and make a microscopical examination of the portions curetted away. Here, again, the danger of infection with carcinoma is so great that we believe the practice should be absolutely abandoned.

Operative technique. The danger of infection with carcinoma during the operation should be thoroughly borne in mind, because it is not necessary during the operation to wound any portion which has been infected. If the mass projecting from the cervix has a cauliflower appearance it should be removed by means of a cautery before the operation is begun, because in this way all of the surfaces through which the incision is to be made are destroyed by the heat, and consequently an infection from them is not possible. After the cervix has been cleansed by means of the cautery, if the carcinoma be cervical in character, a pair of volsellum forceps may be inserted a sufficient distance away from the carcinomatous tissues to insure that they do not cause implantation into the latter. The vaginal mucous membrane is then severed circularly around the entire cervix, at a distance of at least two centimeters from the margin of the diseased tissue, by means of a Paequelin or an electric cautery. We believe that some of the recurrences in our cases have been due to a neglect of this plan. Since we adopted the plan of severing the vaginal mucous membrane with the cautery a number of years ago we have had no recurrences in the vagina, while formerly this was a common location for recurrence.

The uterus is then drawn downward, and the dissection carried on in front and behind by means of the cautery until the peritoneal layer is approached, care being taken throughout this part of the operation to avoid injuring the bladder in front and the rectum behind. The location of the bladder may be determined by occasionally inserting a steel sound through the urethra throughout the progress of the operation. After the dissection has been carried to this point by means of the cautery, the peritoneal cavity is opened anteriorly by blunt dissection with the finger, and then it is opened posteriorly in the same manner and a piece of sterilized gauze carried behind the cervix into the cul-de-sac of Douglas in order to prevent the soiling of the latter cavity from the cervix. The fundus of the uterus is then brought to the anterior opening in the peritoneal cavity, or through the posterior opening, according to the direction in which this can be accomplished most easily. If the fundus is brought down posteriorly, then a piece of sterile gauze should be inserted anteriorly to protect the peritoneal cavity against soiling.

The manner in which the uterus can be brought down most conveniently is by means of the cat's-paw retractors, as indicated in the plate. The ovary and tube on one side are then brought forward into the wound by means of

forceps placed upon the broad ligament, or by digital manipulation. Then a pair of heavy, long-jawed compression forceps is applied to the broad ligament beyond the ovary and tube from above downwards, in order to avoid the ureters. These forceps should be so constructed that it is impossible for the

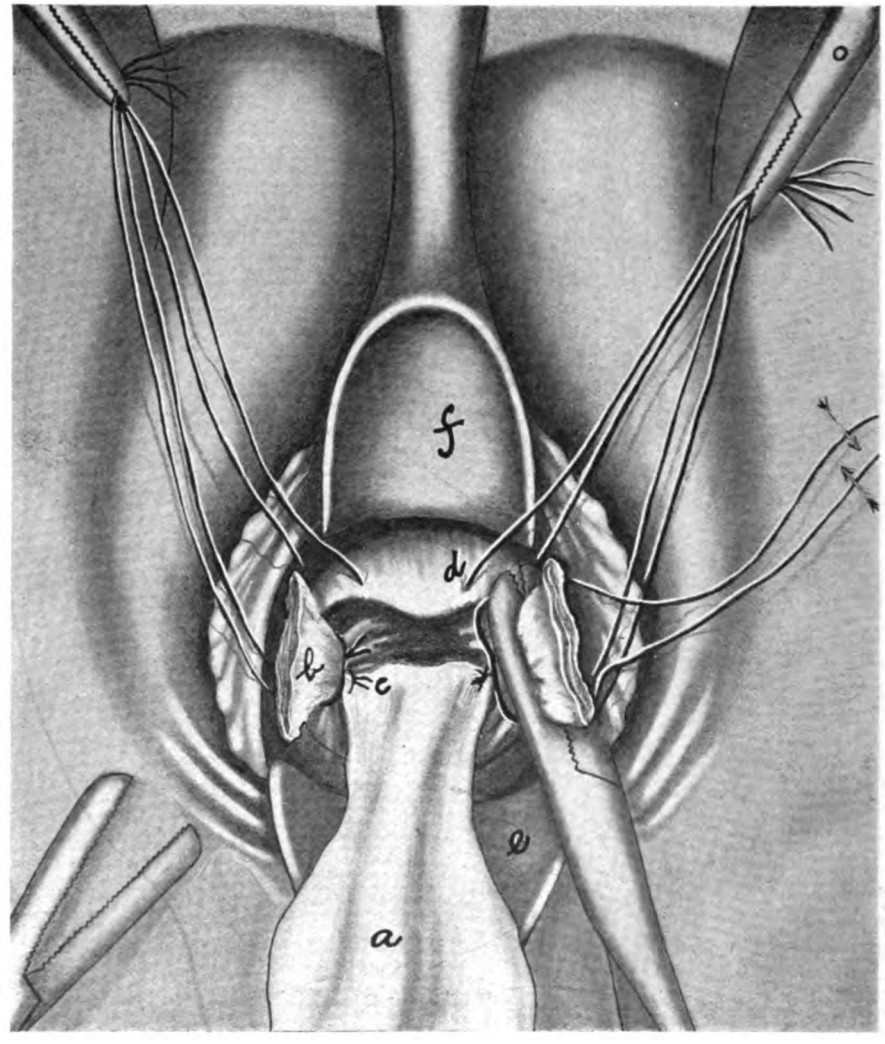


VAGINAL HYSTERECTOMY.

The orifice is held open as in the previous plate. The peritoneal cavity has been opened in front and behind the cervix and the uterus has been brought down and inverted by means of traction with the cat's-paw retractor (c).

tissue to slip out of their grasp. The broad ligament is then cut along these forceps and a second pair of the same kind is applied to the remaining portion of the lateral pedicle containing the remainder of the broad ligament, together with the uterine artery. The remainder of the pedicle is then severed and the uterus is attached now only upon one side. It is then an easy matter to bring

out the other ovary and tube and to clamp the pedicle beyond these in the manner which has just been described. The uterus is then entirely cut away. A strand of iodoform gauze is placed over the ends of these forceps in order to prevent them from doing injury by coming in contact with the intestines in the



VAGINAL HYSTERECTOMY.

The uterus has been removed; the left broad ligament is still held with clamp forceps, the ligature being in place, but not tied. The clamp forceps have been removed from the right broad ligament (b) and the ligature has been tied. A piece of iodoform gauze has been sutured to the stumps of the broad ligaments with two cat-gut sutures (c).

peritoneal cavity, and then the points of the forceps are pushed up into the peritoneal cavity beyond the vaginal wound. A further tampon is placed in the opening in the vagina, and the outlet of the vagina is tamponed with a piece of iodoform gauze, thoroughly saturated with vaseline, in order to prevent the soiling of the deeper tampons from without. The introduction of a

retention catheter and the application of the external dressing completes the operation.

It has seemed to us that there exists a distinct advantage in using the clamps for the purpose of hemostasis in preference to a ligature, because the line of incision through the pedicle, which might be a favorable field for infection with carcinoma, is thus eliminated on account of the sloughing which takes place in the portion contained in the bite of the forceps.

After-care. The forceps are left unmolested for twenty-four hours or thirty-six hours, when they are loosened and left in place so that the portion contained in the bite of the forceps may spontaneously retract from the latter. Several hours later the forceps can be withdrawn without giving the slightest amount of pain to the patient, while if they are withdrawn at once upon being loosened the act is usually accompanied by a considerable amount of pain, and occasionally hemorrhage. The most superficial tampon is removed at the time of removing the forceps and fresh vaseline is applied to the parts. The deeper tampons are removed from the fifth to the eighth day, as they become loosened. About the tenth day the speculum is introduced and sloughs which have become loosened by this time are removed by means of dressing forceps. After the last piece of gauze has been removed the patient is given warm douches of some mild antiseptic character, from three to six times a day, care being taken to have the fountain syringe very slightly elevated, so that it is not possible for the stream to injure the adhesions which have formed in the upper portion of the wound. These douches are a source of comfort to the patient and are perfectly harmless if given in this manner. The retention catheter is left in place until all of the gauze tampons have been removed, unless it gives rise to discomfort, in which case it may be extracted sooner, and the urine withdrawn by means of catheterization. If the catheter is left in place too long it may become filled with phosphatic concretions, unless a few drops of a dilute mineral acid be given in a considerable quantity of water three to six times daily.

A very comfortable external dressing consists of pads saturated with one part of alcohol and two parts of hot water, and covered with a large piece of dry cotton held in place by means of a T-bandage. Aside from this the after-treatment is the same as in any ordinary abdominal section.

Radium therapy may well be considered under two headings: (1) The indications for the treatment, (2) the technique and the clinical manifestations observed during and following the treatment.

We commonly classify cancer cases for purposes of treatment into several groups: operable, borderline, inoperable, terminal or hopeless, and recurrent cases. We thereby indicate at once the method of treatment to be applied in the first group.

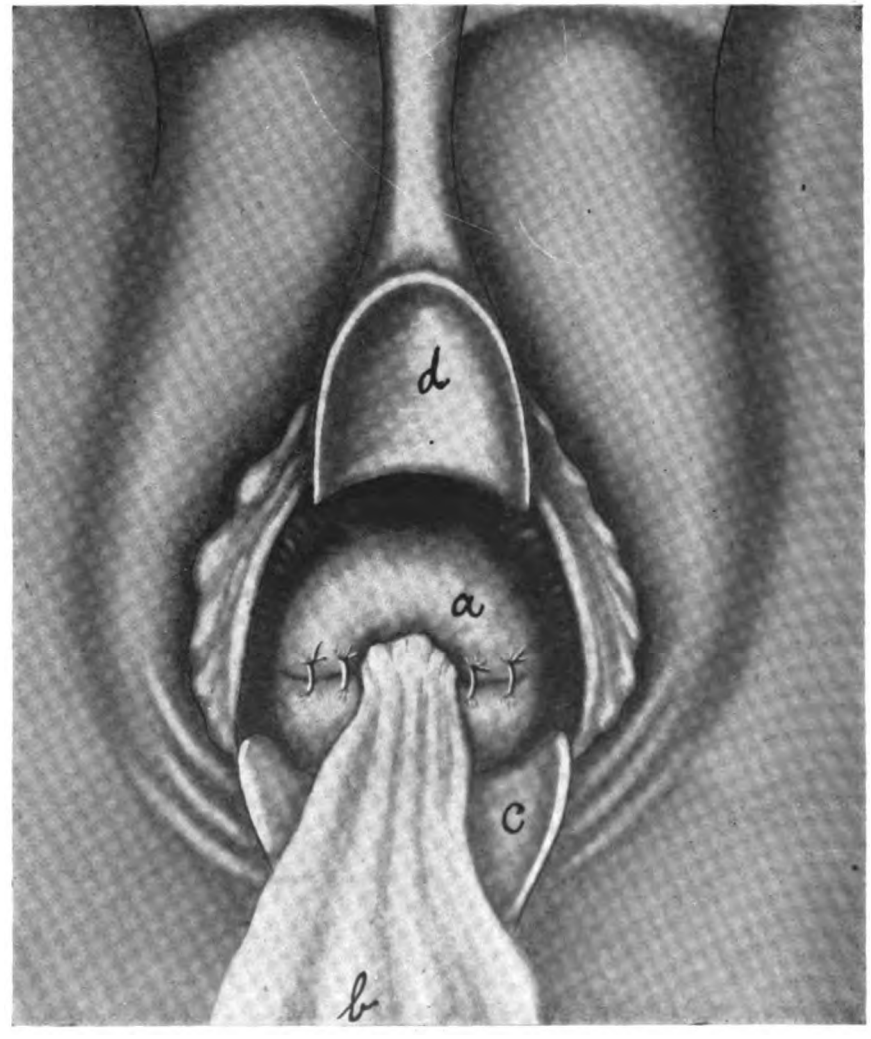
An operable carcinoma is one in which the primary growth is clearly confined within the boundaries of the uterus. A surgical removal of the generative organs will effectually eradicate all carcinoma cells from the body of the bearer. A permanent cure is the rule.

A borderline case is one in which the primary growth is advancing into one of the contiguous organs or tissues. An extended radical abdominal panhysterectomy will not result in a complete removal of all cancer elements. A recurrence is probable. A permanent cure is impossible in the greater percentage of these cases.

Clearly inoperable cases may be divided into two groups: The one shows invasion of the bladder, rectum, parametria or regional lymph nodes,—either of one, several or all of these structures,—yet the uterus and adnexa are not fixed to the bony pelvis. The other is characterized by an invasion of all of the pelvic structures which are firmly fixed to the bony girdle. The iliac and lumbar lymphnodes are mostly already involved and metastases have probably formed in distant organs. The latter are absolutely hopeless from the standpoint of treatment.

The recurrent cases are those in which the cancer recurred after a surgical incision. Should the recurrence be located in the vaginal fornix they yield readily to treatment. Should the growth recur in the regional lymph-glands or the distant portions of the parametrii, they are hopeless.

Accordingly the grouping is as follows: 1. Cases clearly operable after a physical



VAGINAL HYSTERECTOMY.

The operation completed. The orifice held open by the specula (c) and (d). The vaginal vault (a) closed by tying the sutures. The iodoform gauze drain (b) in place.

examination. 2. Cases doubtfully operable—"borderline cases." 3. Cases in which a radical operation is absolutely impossible. 4. Cases so far advanced that all treatment is hopeless and that are subjected to it for purposes of palliation. 5. Cases that recur after an abdominal panhysterectomy.

It is obvious that we must adhere to a classification as given to determine fixed rules

for a proper mode of treatment, to enable us to arrive at a proper determination of the efficacy of any therapeutic measure, and to compare the value of ray therapy with other treatments advocated.

Clearly operable cases indicate a radical, extended abdominal panhysterectomy. Should contraindications exist, then the patients are subjected to radium treatment. Many therapeutists have proposed a prophylactic raying following operations to prevent recurrences; others recommend pre-operative raying to cause a degeneration and death of the tumor elements first, thus to prevent accidental dissemination of viable carcinoma cells during the progress of the operation. It is claimed that by either method the efficacy of surgical procedures would be improved. The value of such combined treatment can be determined only by a proper subgrouping and a careful collection of these cases. The advantages of such procedures would soon be established beyond any doubt.

The results of surgical treatment of borderline cases have been so disastrous that most surgeons refuse to treat them. This class of patients, however, forms the most ideal group for radium therapy. When we began the investigation of the value of radium therapy we were quite undecided whether a patient should or should not be subjected to a radical incision of the pelvic organs after a complete local regression of the tumor was obtained by ray therapy. Also we did not know whether an excochleation and cauterization of the tumor mass preceding the course of radium treatment would or would not improve the prognosis. Therefore we must subgroup these cases, stating (a) whether they were treated with radium only; (b) whether a local healing was obtained with radium and an excision followed; and, (c) whether an excochleation and cauterization preceded the radium treatment.

The clearly inoperable cases of Group 3 form the largest number. Here also the same conditions prevail as in Group 2. Therefore a similar subgrouping was adopted: cases treated with (a) radiation and panhysterectomy, (b) extensive cauterization and panhysterectomy, and (c) radiation only.

The hopeless and recurrent cases require an entirely different form of treatment, as will be stated later. Tables 1 to 7 show at a glance the grouping of the cases that were treated in our clinic from April 1, 1914, to April 1, 1920. They also give information about the time elapsed since treatment in those patients that have survived so far, and the time elapsed between treatment and subsequent death.

In grouping the cases and stating results we have not made any effort to classify them according to the technique employed. The latter has been changed from time to time. At first we used 50 milligrams of radium element, filtered with 2 mm. of lead or 1.2 mm. of brass, arresting the Sagnac rays by a pure para-rubber filter of 3 mm. thickness. The 25 milligram tubes were arranged either parallel and placed against the cervix, or in tandem and inserted into the crater. The applications lasted 20 to 24 hours, and were repeated every second or third day until 6,000 to 14,000 milligram element hours were obtained. We soon observed that 4,000 to 6,000 milligram element hours applications usually caused a marked restitution of the diseased area to nearly normal and decided to apply the dosage in one sitting, allowing the 50 milligrams to remain in situ for three to five days. Finally we shortened the duration of the application by using from 100 to 200 mgs. of element. If a decided change for the better did not occur in the local condition within three to six weeks another course of treatment as intensive as the first one would again be applied.

Whatever method we used none seemed to give as satisfactory results as the twenty-four hour interval application of 50 milligrams of radium element. The patients objected less, had fewer systemic reactions, rarely an infection and never an exitus directly attributable to the treatment. The following study and investigations enabled us to formulate a mode of treatment that we consider ideal, safe and successful.

The technique of radium therapy must be based on the diseased conditions found in the pelvis in uterine carcinoma. The purpose of the treatment is to destroy the cancer completely without producing serious injury to the surrounding healthy tissues and organs which would render illusory the first object.

The vaginal portion of the cervix lies in the interspinal line, the cervix, lower part of the uterus and parametria lie somewhat higher. A plane through the antero-posterior diameter of the midpelvis well defines the limit of the disease upward. Cervical carcinoma spreads by invasion of the vaginal vault, by infiltration of the lymph vessels of the parametria, by extension into the para-vaginal tissues and along the sacro-uterine ligaments to the pararectal tissues and rectum, and through the vesico-vaginal septum to the bladder. The part of the pelvis between the pelvic outlet and the midpelvic plane contains all these structures and is the space which must be rayed. The transverse and antero-posterior diameters of the midpelvic plane are twelve centimeters long, the transverse diameter is eleven and one-half centimeters long. The cervical canal lies in the pelvic axis. Hence *a radium capsule placed within the cervical canal will disperse the rays evenly through the pelvic cavity. The rays must penetrate six centimeters of tissue all around with such an intensity at the periphery that carcinoma cells at this distance become destroyed.*

We must also endeavor not to injure permanently the vital organs and structures located in this area, namely, the rectum, the bladder and the ureters. The posterior wall of the bladder, the anterior wall of the rectum and the ureters are one and one-half centimeters distant from the cervical canal if the organs are empty. Should the bladder and the rectum be filled they are forced closer to the cervix and the distance is reduced to about one-half. Therefore it is necessary that the bladder and the rectum be empty and left empty during the treatment. This will be understood when discussing dosage. *We insist on the insertion of a retention catheter in the bladder and the flushing of the bowels immediately before beginning the treatment.*

The amount of radium to be used depends on the extent of the radio-activity of the preparation of radium and the extent of the area to be rayed. We must use the smallest amount permissible. Overdosing leads to dangerous complications as extensive necrosis and destruction, infection, painful cicatricial tissue formation causing stricture of the rectum, vagina, ureters, and so forth. The systemic reaction, also, places a limit on the amount of radium it is advisable to use, as rapid disintegration of diseased and normal cells leads to severe absorption and sometimes pronounced toxemia that might prove fatal.

The object of the application of radium is to apply a given amount for a sufficiently long time to destroy the deeply-located pathologic processes within the pelvis without permanent injury to the healthy tissues and organs. This dosage can be determined only by the biologic measurements of each radium preparation. Dosage is a complex quantity and comprises the quantity of radium in milligrams of element, the length, width and depth of the container, the purity of the salt, the filtration, such as rubber and metal filters, the distance of the radium from the area treated, the time duration of the exposure, and the time intervals between exposures. The tubes used in our clinic contain each 25 milligrams of the element in the form of the insoluble sulphate of a chemical purity better than 94 per cent. The salt is packed in a glass cylinder of an outer diameter of 2 mm. and a length of 6 mm. The glass cylinder is inserted in a silver capsule of a wall thickness of 0.5 mm. and a length of 1.75 cm. We place two such capsules in a brass filter of 1 mm. thickness. The metal filter therefore is 1.5 mm. and effectually absorbs the beta radiation. The Sagnac rays formed in the metal filter are absorbed by a rubber tubing of a wall thickness of 3 mm. in which the radium carrier is inserted. If such a container is placed over healthy skin at a distance of one centimeter between the axis of the radium capsule and the skin surface then a reddening of the skin is observed within ten to fourteen days after an exposure of somewhat less than two hours. This dosage is termed an erythema skin dose and amounts to about two times 50 milligrams, i. e., 100 milligram element hours (mgehrs.). If the exposure is increased to two and one-half to three hours a blistering appears after ten to fourteen days. A burn of the second degree has been caused. Should the exposure be extended to twenty hours a burn of the third degree results,—the epithelium has been totally destroyed. The erythema and the second degree burn heal very rapidly without leaving a permanent

defect behind. Should the radium carrier be applied at a distance of two centimeters then an erythema dose is obtained within eight hours, and a blister dose within twelve hours, because the intensity of the rays decreases inversely with the distance.

The sensibility of carcinoma tissue to rays is held to be about one-half greater than that of normal tissue. This does not agree with the findings of Kroenig and Friedrich. They found that an erythema skin dose is obtained by an application of rays measuring 170 electrostatic units determined with a Wolf electrometer. They consider this the lethal skin dose. The dose that causes after a certain time interval, usually fourteen to twenty days, a visible and palpable decrease of the carcinoma growth is termed a carcinoma dose and is 150 e. The cancer sensibility quotient is obtained by dividing the skin dose with the cancer dose, i. e., $170 \div 150 = 1.15$. By biological tests we found that the erythema skin dose is about 100 mgehrs. Hence the cancer dose must be $170 : 150 = 100 : X$ and $X = \frac{150 \times 700}{170}$ $= 88\frac{1}{17}$ mgehrs., or in round numbers 90. It has been impossible to install an electrometer to verify the measurements of Kroenig and Friedrich. We do not see any objections to them as the experiments have been very scientific, thorough and accurate. Applying the law of the inverse ratio to these results we find that the lethal erythema cancer doses for distances 1, 2, 3, 4, 5 and 6 cm. respectively are 90, 360 810, 1440, 2250 and 3240 mgehrs.

If the radium carrier is placed in the cervical canal after a proper dilatation then the posterior wall of the bladder and the anterior wall of the rectum are forced two centimeters distant from the radium source. A ten hour application, or 500 mgehrs., would not injure the bladder or the rectal walls to the extent of a second degree burn. However, it would visibly and palpably damage the cancer tissue within a radius of two centimeters, as the cancer dose would be four times 90 or about 360 mgehrs. We may assume that the healthy cells of the bladder and the rectum will rapidly recover so they will bear another application without permanent harm after an interval of twelve to fourteen hours, and so on until seven treatments of 500 mgehrs. each have been applied on seven consecutive days, i. e., a total amount of 3500 mgehrs., the amount necessary to degenerate all carcinoma cells as far as the bony pelvic wall. As a matter of fact cystoscopic examinations made at ten day intervals and extended over a period of six weeks have verified the correctness of the assumption. We have never observed a marked change in the bladder mucosa except an intense reddening.

The patient is subjected to careful re-examinations in ten days, thirty days and then every forty-five days for two years and every three months for an additional three years. Exact records are made each time. They note the visible findings of cervix, vagina, bladder and rectum and the palpable conditions of the uterus, parametria and regional lymph glands obtained by vaginal and rectal palpation. The radium treatment is not repeated unless a recurrence is surmised.

The after-treatment must also comprise adequate drainage of the uterine cavity. Pyometra has been frequently observed. In such cases a soft rubber T-drain is inserted into the uterine cavity after each removal of the radium carrier and continued for several weeks after termination of the treatment until the secretion is reduced to a clear and negligible amount.

Three to four weeks after treatment a careful examination reveals a visible and palpable decrease of the cancer area. The cervix shows local healing. The uterus is palpable and movable, the parametria are softer in consistency, reduced in size and again movable and very often rendered free of any induration.

Such favorable results can be obtained only by a careful selection of cases. The technique described is indicated and can be successfully applied only in Groups 2 and 3. It is absolutely useless in Group 4, the terminal cases. It is impossible of execution in Group 5 on account of the absence of the uterus. Cases in Group 1, of course, are subjected to abdominal panhysterectomies after a preliminary radiation.

Properly selected cases reveal a visible and palpable subsidence of the cancer growth

after a correctly applied radium course. A panhysterectomy could be easily performed. The operation would not present unsurpassable technical difficulties. Could the dangers of an added operation hold out to the patient a more favorable prognosis? Out of a total of 208 uterine cancers treated from April 1, 1914, to April 1, 1920, with radium, twenty-two cases were assigned to Group 2 and eighty-two cases to Group 3. Thirteen of Group 2 were subjected to an abdominal panhysterectomy after a recession of the diseased tissue to an apparently normal state after radium treatment. Of these five are living and five have succumbed either to the operation or to a recurrence, and three did not report. Nine of Group 2 were treated with rays only—seven are alive and well, and two have died. Sixteen cases of Group 3 were subjected to panhysterectomies after an apparently local healing. Two of these are living, while ten have succumbed and fourteen did not report. Twenty-five cases were subjected to an excochleation, cauterization and radium treatment. Four cases are living, but nine died and twelve did not report. Forty-one cases were treated with radium only. Eighteen of these are well and free of recurrence, while eleven died and twelve did not report. (See Tables 1 to 7. They also state the time elapsed since treatment of those living and known dead.) Patients of Groups 2 and 3 treated with radium only and not subjected to panhysterectomy, excochleation or cauterization have a better chance all around. If local healing is obtained we should not subject the patient to an unnecessary operation. Preliminary excochleation and cauterization also do not offer the patient any additional benefits. They render her chances less favorable in spite of the added physical and material sacrifices.

Recurrences after a local healing of the carcinoma with radium appear within six to nine months, rarely later, following the termination of the treatment. It is a noteworthy fact that such recurrences are very refractory to radiations, probably due to the heavy connective tissue reparative process. Exceptionally an arrest and recession of the recurrence may take place following another course of radiation. If the growth does not react to the treatment and if the recurrence is confined to the uterus we then advise surgical eradication. Should the recurrence appear in the regional lymph nodes we have subjected the patients to laparotomy, buried canals into the tumor masses, in which we placed rubber tubing. The tubes are secured with silk stitches to the parietal peritoneum of the posterior abdominal wall and also to stab incisions in the anterior abdominal wall. The length of the tubes must be carefully determined. The radium applicators are secured to a heavy silver wire which easily adapts itself to the course of the tubing. Two to four applications of 50 milligrams radium element of ten hours each, with intervals of twelve to thirty-six hours between applications, are given.

We have subjected five patients to the procedure without any apparent benefits. Two patients succumbed to peritonitis. Three had a tedious convalescence. Of the latter one succumbed six weeks later. She had a large metastasis in the liver. Another expired six months later from a carcinomatosis. The third one reported not to be relieved and has not been heard from since. In spite of these discouraging results we shall continue the treatment in specially selected cases of such recurrences.

Cases of Group 4 have been benefited only exceptionally by the above outlined treatment. The fact that the dangers from toxemia due to the absorption of split products and infection are very great has induced us to desist from the plan. We usually apply 50 milligrams element for twenty hours placed against the crater. This will cause an arrest of hemorrhage and a subsidence of the putrid discharge. As soon as the symptoms of absorption or infection, or both, subside, i. e., in about ten days, we make a second application of 50 milligrams element for twenty hours within the cervical canal. Should reaction or infection not appear within three days and the examination of the blood does not reveal a leukopenia, then a full course as outlined for Groups 1, 2 and 3 is resorted to.

We must also consider the clinical limitations or contraindications for radium applications. They are given by the systemic reaction of the organism and the possibility of infection.

Mild subjective disturbances as nausea, vesical and rectal tenesmi, do not necessitate

an interruption of the treatment. Serious disturbances due to the absorption of cell constituents liberated by the degenerative and destructive action of the radium rays are intense weakness, apathy, anorexia, absolute refusal for intake of all food, serious changes in the blood elements, especially leukopenia, and finally radium cachexia. They compel an interruption of the treatment.

Infections result from the bacteria ever present in cancer tissues. The bacteria enter the pelvic organs and tissues through the injured mucosa of the vagina, uterus, rectum or bladder. The injuries result from necrosis or destruction by the action of the rays. Toxic substances accumulating in the bowel tract, the result of the toxemia, are also readily absorbed through an injured rectal mucosa. Bacterial invasion causes inflammatory changes in the paracervical, paravaginal and pararectal connective tissue, the uterine adnexa, the pelvic peritoneum terminating in diffuse septic peritonitis or sepsis.

The dangers can be avoided only by a correct dosage that gradually degenerates the tissues and avoids necrosis of the surface epithelium especially of the rectum. A most careful asepsis observed in the application of the rays, insuring free drainage from the uterine cavity, and careful dilatation of the cervical canal to avoid all unnecessary trauma, must be insisted on.

Metastases occurring above the midpelvic plane and beyond the bony pelvic outlet are not acted upon by the radium rays with a sufficient intensity to become degenerated. Therefore we combine the application of radium rays with that of massive and deeply penetrating roentgen rays.

The technique at present in use at our clinic is as follows: The suprapubic area is divided into two fields of 10 cm. square. A similar area is mapped out over the perineum, the patient being placed in the left lateral Simm's position. To each field from 225 to 300 m.a.m. of hard roentgen rays are applied. Coolidge tubes are used exclusively; the milliamperage is 5, the voltage 100,000 controlled by an autotransformer and a Heinz-Bauer qualimeter, the focal distance about 30 cm., the filter 10 mm. aluminum and one thickness of sole leather. Therefore the duration of an application to each field is from 45 to 60 minutes. The patient must be carefully protected with leaded rubber cloth to prevent injury from dispersed rays always emanating from a Coolidge tube. The amount of rays thus applied to a field leads to a deep brown discoloration within ten to fourteen days, an indication that an erythema skin dose has been reached. In fair-complexioned people 225 m.a.m. are considered safe, while in dark-complexioned people 300 m.a.m. can be given with safety. Of course the only exact determination of electrostatic units used on each field should be made with an electrometer. 170 electrostatic units equal an erythema skin dose. By increasing the voltage to 180,000, the focal distance to 50 cm. and the filter to 18 mm. of aluminum or 1 mm. of copper, the application would require only one field of a diameter of 15 cm. It would be necessary, however, to construct Coolidge tubes that could carry a current of such high voltage. The problem will be solved within the near future. The advantages of the procedure would be uniform intensity and hardness of the rays throughout the entire area subjected to treatment.

COMBINED VAGINAL AND ABDOMINAL HYSTERECTOMY

In more advanced cases the combined vaginal and abdominal operation has been advised by many authorities, because it has been claimed, especially by Ries, that it will be possible to remove the infected glands by following this method, and thus to prevent recurrence in cases in which the removal by the vaginal route would be useless. It is doubtful whether it is possible to remove all of the infected glands in any case in which the lymph nodes at some distance from the uterus have become infected with carcinoma, but there is no doubt that this operation is more thorough than the one just previously described and the increased danger is so slight that the operation is at least justifiable in any case in which it seems plain that the disease cannot be

removed entirely by the vaginal route, and is not sufficiently advanced to absolutely contraindicate an attempt at a removal.

In our own experience these patients have, however, lived longer as a rule, when we have treated the growth with very extensive destruction with the actual cautery, which seemed to be more far-reaching in its effect than removal by the most careful dissection.

In making the combined operation it is important to remove all of the lymph nodes in the broad ligaments and along the iliac vessels. This dissection is best accomplished by splitting the peritoneum and then dissecting away the fat and the lymph nodes with a gauze pad, according to the method described in connection with the removal of fat and lymphatics of the axillary space for carcinoma of the breast.

All of the raw surfaces are then covered with peritoneum and a gauze or cigarette drain is passed down into the vagina.

It is best to begin the combined operation from below, burning away the vaginal attachment precisely as described in the previous operation and grasping the broad ligaments from below and clamping the lower portion of the broad ligament on each side with strong hemostatic clamps and burning between these and the cervix with the actual cautery. This space is then thoroughly tamponed with gauze and then the patient is placed in the Trendelenburg position and the operation completed through a large abdominal incision, as before outlined.

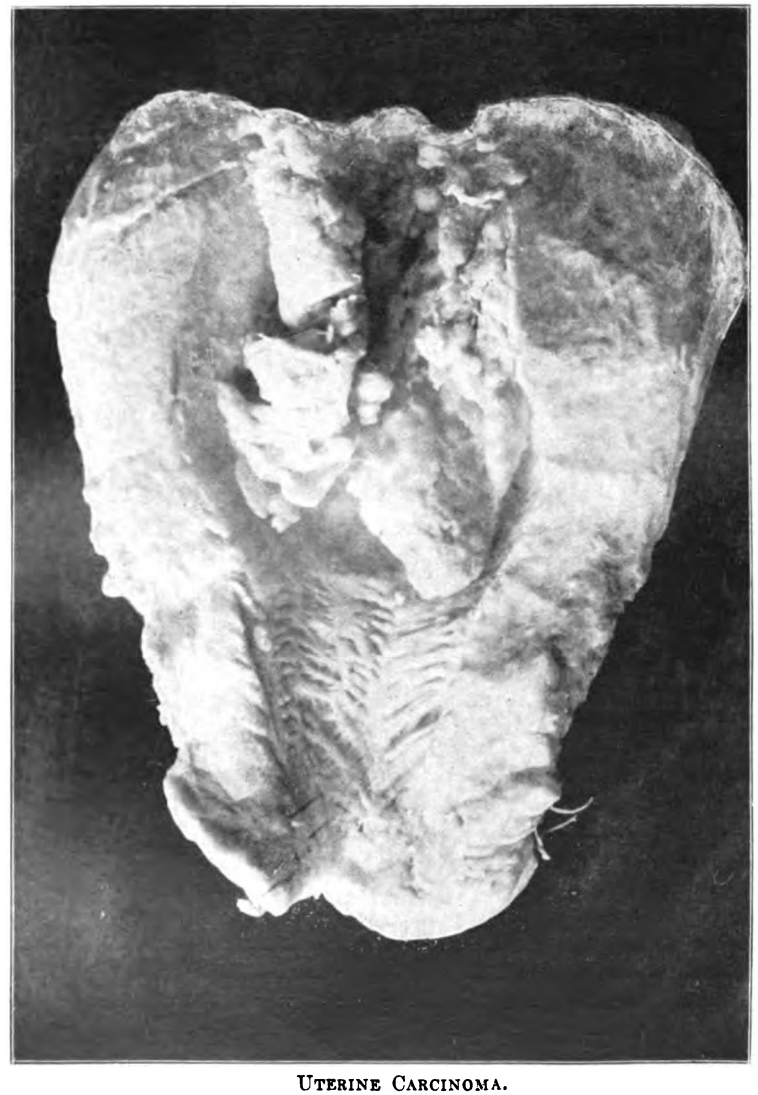
The after-treatment is the same as before described.

VAGINAL HYSTERECTOMY FOR NON-MALIGNANT CONDITIONS

In severe uterine hemorrhage, due to the presence of small uterine fibroids, which cannot be controlled by means of simpler methods, a vaginal hysterectomy is indicated because of its easy execution, that it does not give rise to a scar and is as safe as the abdominal method. In this case it is not necessary to make the vaginal incision by means of the cautery. The remaining steps of the operation are the same as in vaginal hysterectomy for carcinoma, but there is no necessity for leaving the pressure forceps in place, and the patient's comfort is increased by applying a ligature around the portion of the pedicle containing the uterine artery, as indicated in plate, and a second ligature around the remaining portion of the pedicle, as next shown, so that two ligatures will take the place of the two pressure forceps in the operation which has just been described. The ligatures should be passed through the pedicle in a manner which will prevent their slipping, because a careless application of ligatures at this point might result in a dangerous hemorrhage. Two catgut stitches are inserted through the edge of the wound to one side of the center and left untied, as indicated, until the tampon of iodoform gauze has been fastened to each of the two lateral pedicles by means of a small catgut stitch, as shown. The tampon should then be shoved up into the abdominal cavity, together with the two lateral pedicles, and then the stitches in the wound are tied. This provides for the approximation of the two lateral pedicles and for the closure of the vaginal wound, and also for a sufficient amount of capillary drainage. The approximation of the lateral pedicles is especially valuable in case the operation is performed for the relief of complete prolapsus of the uterus, because in this manner a support for the floor of the pelvis is provided. A retention catheter is inserted as before and the after-treatment is carried out in the same manner, the iodoform gauze tampon being removed between the fifth and tenth day after the operation.

In carcinoma of the uterus which is operated early, before the disease has advanced beyond the tissues of the cervix, this operation is also very satisfactory, but in cases which have advanced beyond the incipient stage we have had more satisfactory results when we have used the clamp.

In place of using the ordinary hemostatic clamps we have used Doud's elec-



UTERINE CARCINOMA.

tric cautery clamp in many cases. This clamp is applied to the pedicle as one would apply an ordinary clamp, then a current of electricity is passed through the instrument for fifteen to thirty seconds, which thoroughly cooks the tissues contained in its bite. This at once secures the pedicle against hemorrhage and destroys any malignant tissue which may be contained in the pedicle.

The same clamp is used upon the pedicle formed by the broad ligament in the abdominal operation. By using this clamp the entire operation can be performed without the use of either knife or ligature, the entire surface being covered with cauterized tissue. The results after operations performed with the use of this instrument have been most satisfactory.

The patients do not suffer from shock, neither do they suffer from severe pain after the operation. It is well to mention these facts because they dispose of theoretical objections that might arise.

PROLAPSE OF THE UTERUS

In prolapsus of the uterus in patients advanced in years, in which the tissues of the broad ligament seem to be fairly substantial, the operation which has just been described, performed without the use of the cautery clamp, has given most satisfactory results. If, however, the entire vaginal mucous membrane, together with the posterior wall of the bladder and the anterior wall of the rectum, show a tendency to prolapse, these latter structures are likely to continue to descend after doing the operation above outlined, and in such the patients will be but slightly improved unless a more extensive procedure is chosen.

The operation which seems to invariably give relief in these cases consists in the additional removal of the entire vaginal mucous membrane and the closure of the entire canal by means of buried catgut sutures. The operation which has just been described is performed without the use of the cautery clamp, and with the exception that the two lateral pedicles are united to each other broadly by means of buried chromicized catgut sutures, and then the entire mucous lining of the vagina is dissected out from above downward, leaving a raw canal throughout. This is closed by a series of buried catgut sutures from above downward, and at last the skin at the entrance of the vagina is united by means of a longitudinal suture extending from a point two centimeters above the meatus urinarius down to the anterior edge of the perineum. In applying the buried catgut sutures it is important that neither the rectum nor the bladder be wounded, for fear of producing a recto-vesical fistula.

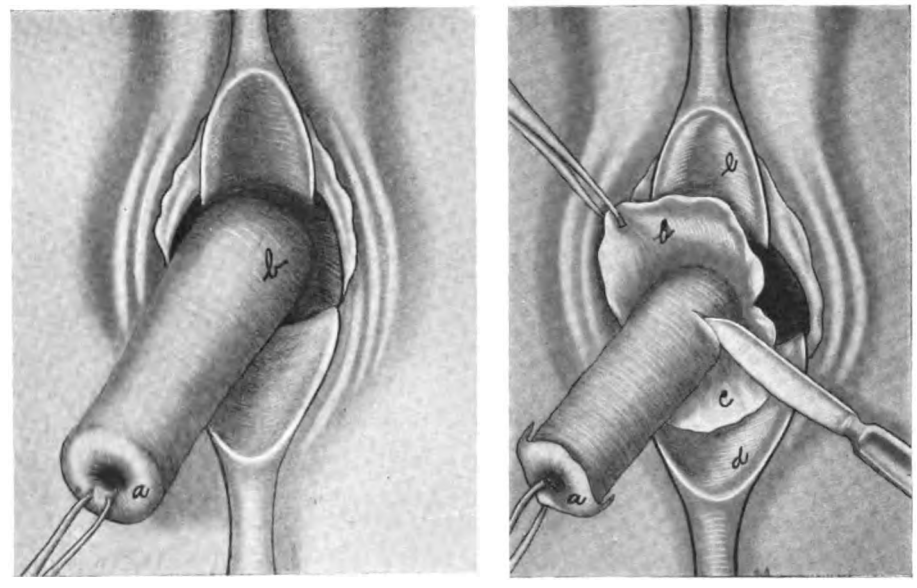
The after-treatment is the same as after an ordinary abdominal section.

Prognosis. The prognosis in this operation is very favorable. In prolapsus of the uterus in younger patients it is usually found that the displacement is due to an abnormal elongation of the cervix. There seems to be a tendency on part of the tissues of the vagina to make traction upon the elongated cervix and thus cause a prolapsus of the uterus. The replacement of the latter is of no apparent benefit to the patient, and the support by means of pessaries seems to be of no avail. If, however, the following operation be employed for the purpose of removing the elongated cervix the broad ligaments seem to be able to support the uterus in its normal position, and the organ will remain in its proper position without any further support.

REMOVAL OF ELONGATED CERVIX

A circular incision is made about the end of the elongated cervix and the mucous membrane surrounding the latter is reflected to a point a little below the upper extremity thereof. This point may be at a considerable distance

from the lower end of the cervix, as shown in the plate, which was drawn from nature, and in which the cervix had reached the length of twelve centimeters. Upon a casual examination it seemed as though there were a prolapse of the entire uterus, but upon careful inspection it was found that only the elongated cervix projected. The mucous membrane was carefully dissected upwards in the anterior and posterior flap, as indicated, and severed just below the upper extremity of the cervical canal. As soon as this portion of the cervix had been cut away the uterus showed a tendency to slip up into the pelvic cavity, and



EXCISION OF ELONGATED CERVIX UTERI.

The elongated cervix (a) (b) withdrawn from the vaginal orifice.

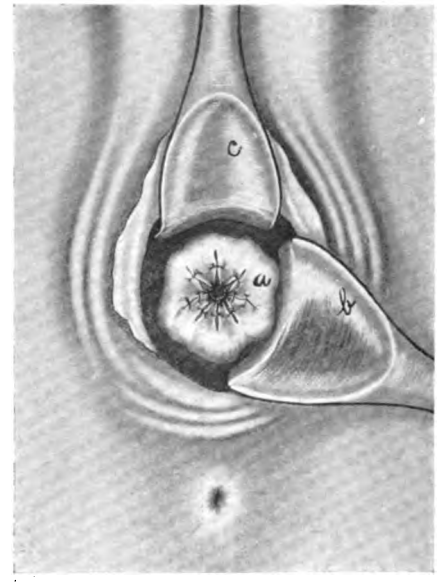
The mucous membrane covering the cervix has been reflected by making an elliptical incision around the cervix (a). Thus an anterior (b) and a posterior (c) mucous flap are formed and the projecting cervix is amputated.

had to be held down in position in order to complete the operation, which consisted in covering the stump with the mucous membrane removed from the portion of the cervix cut away, as shown. This method insures the formation of a normal cervix.

As has been stated before, the uterus showed a tendency to slip up into the pelvis and take up a normal position as soon as it was released from below, even in this greatly exaggerated case. This, however, is not the history in patients advanced in years who have given birth to a number of children. In these the hysterectomy which has just been described is to be preferred.

In cases in which an obliteration of the vagina is not desirable it is best to perform the abdominal hysterectomy described elsewhere, especial care being taken to construct a substantial floor for the vagina by firmly suturing together

the broad and the round ligaments with chromic catgut. This can be done to the required degree by carefully overlapping these ligaments. At the same time it is wise to suture together broadly the recti muscles throughout the abdominal incision.



CLOSURE OF WOUND IN CERVIX.

The flaps of mucous membrane are brought down over the stump, sutured to the mucous membrane lining the uterine cavity, and all raw surfaces are covered with portions of the mucous membrane, making a perfectly uniform stump (a).

EROSION OF THE CERVIX

In many patients, but especially in those whose occupation compels them to stand a greater part of the day, the pressure of the cervix upon the tissues upon which it rests causes a condition of erosion, which, in turn results in the formation of exceedingly hard, cicatricial tissue. This condition is most common in women who have borne children, because in these the uterus has usually not undergone complete involution, and the consequent increase in weight increases the pressure and thus favors the result in question.

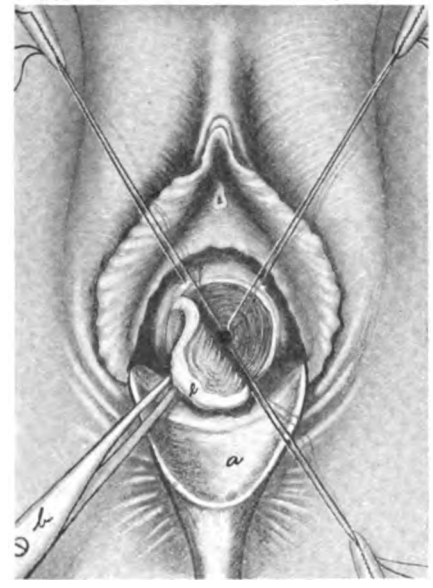
The pressure occurring from the contraction of the cicatricial tissue is likely to produce the symptoms described in connection with laceration of the cervix, and the same treatment is indicated.

LACERATION OF THE CERVIX

Causative factors and symptoms. In a considerable proportion of patients going through childbirth the cervix of the uterus is lacerated. If the wound is not kept aseptic the healing is bound to be slow, and there must result a variable amount of connective tissue. In a second delivery the tissues are less elastic than normal, because of the presence of this cicatricial tissue, and therefore a further laceration is almost certain to occur, which is apt to be more extensive than the previous one. Where the patient can obtain reasonable care during the pregnancy, and during and after confinement, the wound

usually heals so perfectly that it requires no further attention, but unfortunately there is a large class, comprising the most valuable women in the country, in which conditions are such that ideal care during pregnancy and during the after-confinement, is not possible. This class comprises the wives of the mechanics, artisans, farmers and laborers.

Customary history. The patient usually gives a history of having been in excellent health at the time of her marriage, of having undergone a variable number of normal pregnancies and usually a certain number of abortions; the confinement has generally been conducted by a midwife; the patient has felt the necessity of caring for her entire household during her pregnancy; she has had but a slight amount of care during and after confinement; she has not enjoyed the benefits of a trained nurse at such time; she began to perform



AMPUTATION OF LACERATED CERVIX UTERI.

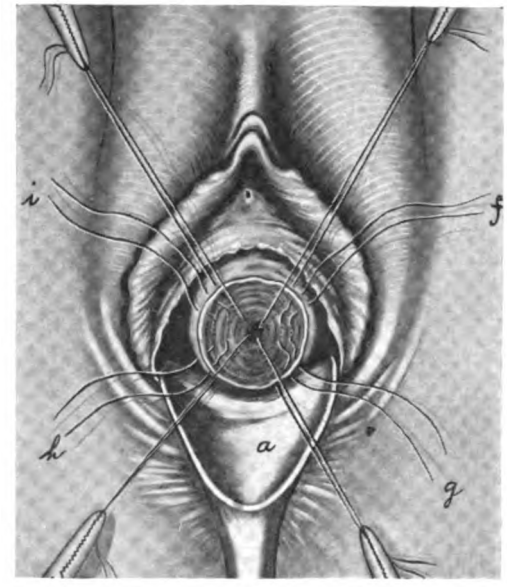
The uterus is drawn down with volsellum forceps (b). An elliptical incision is made around the cervix. The anterior portion (c) is dissected down to the cervical canal. Then sutures (c) and (d) are inserted, uniting the vaginal with the cervical mucous membrane. These are left untied until the lateral sutures have been applied. Then the removal of the cervix is completed.

her regular labors within a short period after confinement; and had the care of her infant and all of her family within a short time thereafter. Usually the first confinements made no marked impression, but later on the patient apparently began to grow old rapidly; to suffer from the sensation of weight in the pelvis, and from pain low down in the back; and she usually complains of feeling tired most of the time. Constipation and lack of strength in securing evacuation of the bowels are usually complained of. Notwithstanding this, the patient frequently has gained in weight, her abdominal walls have become greatly thickened with the accumulation of this fat, but the normal tone of the abdominal walls has been lost. Later on the patient has complained of nervousness, has become irritable, her digestion is impaired, and this condition frequently continues until she is nearly, if not wholly, bed-ridden.

Upon examination the perineal support of the uterus is found to be greatly impaired, the vaginal walls are loose and flabby, the cervix is greatly thick-

ened and edematous, and in a majority of patients there is a laceration of the left side. Occasionally there are several other lacerations of the cervix, all filled with hard, cicatricial tissue. The uterus is found upon bi-manual examination to be considerably hypertrophied, sometimes twice or thrice the normal size—involution not having taken place after the confinements and abortions. The fundus of the uterus may be retroverted or it may be in a nearly normal position. The entire organ is likely to be somewhat prolapsed and displaced backward.

Preparatory treatment. This should be the same as for any ordinary operation, unless the cervix is covered by a septic ulcer. In such instance, it is wise to place her in bed for a few days before the operation is performed.



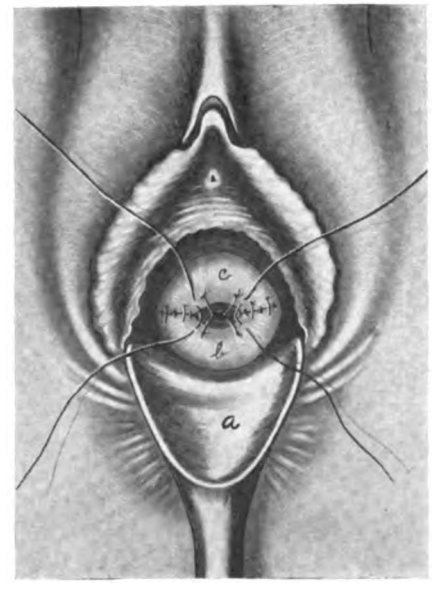
AMPUTATION OF CERVIX UTERI FOR LACERATION.

(b), (c), (d) and (e) represent the sutures which unite the mucous membrane of the vagina with that of the cervical canal, preventing closure of the latter; (f) (g) and (h) (i) represent the sutures on either side which cover the raw surface resulting from the excision of the cervix.

to give large, very hot douches from three to six times a day, and at night apply some antiseptic, such as compound tincture of iodine, equal parts of compound tincture of iodine, glycerine and carbolic acid, or a tampon of twenty-five per cent. ichthyol in glycerine. During this period of treatment the patient should also receive mild laxatives and light diet.

Operative technique. The treatment we have found most valuable in these cases consists in the removal of all of the hardened tissue in the cervix and then covering the abraded surface with vaginal mucous membrane. A broad vaginal speculum is introduced, as shown in the plate, and a volsellum forceps applied to the posterior lip of the cervix. With this it is drawn downward and a little forward, and an elliptical incision, including all the hardened tissue in the cervix, is made with a sharp scalpel. The posterior lip is not entirely severed during this stage, but the anterior lip is severed down to the cervical canal. Then two chromicized catgut stitches are applied to the anterior lip in the following manner: One-eighth of an inch of vaginal mucous mem

brane is grasped with a short-curved needle, as shown. The needle at the same time grasps about one-third of the thickness of the underlying muscle; then it is reintroduced into the cervical tissue and the same amount of tissue, including the mucous membrane lining the cervix, is grasped with these sutures. These sutures are then left untied until the remaining portion of the operation has been completed, when their tying will approximate perfectly the vaginal mucous membrane and that lining the cervical canal. These two sutures will serve to manipulate the uterus during the remainder of the operation. The hardened tissue is now completely cut away, leaving the cervix as shown in plate. Two further sutures are inserted posteriorly, corresponding to those applied anteriorly before the cervix was entirely cut away. These are also left untied. Two additional sutures are then passed on each side, grasping the mucous membrane in front; then to the substance of the cervix to each side



AMPUTATION OF CERVIX UTERI.

This plate shows the operation as completed after all of the sutures have been tied and superficial sutures have been inserted to secure accurate coaptation of the mucous membrane.

of the cervical canal; then to the mucous membrane behind. After all of these sutures have been applied they are tied successively, the outer ones being tied first; the two sutures grasping both the vaginal and the cervical mucous membranes being left to the last. After all of these have been tied the entire abraded surface will be covered, with the addition of a few coaptation sutures, as indicated in the plate.

This leaves the cervix in as nearly an ideal condition as possible, and in case of a future pregnancy it is no more likely to become lacerated than it would be had it never had a laceration and the reparative operation. In quite a considerable number of patients we have observed the outcome after a future confinement, and in all of these the condition has been most satisfactory.

The chromicized catgut to be used should be prepared so as to absorb within about two weeks. This will dispose of the annoyance of removing the stitches. It is important in this operation that the stitches be not drawn too tightly, as a certain amount of edema is sure to occur, which is greatly increased if the

stitches are tied tightly. In this event each stitch will leave a line of pressure-necrosis across the surface to be occupied by hard nodular tissue. The removal of the hard connective tissue is the most important benefit the patient derives, and consequently nothing should be done in the operation which might give rise to a recurrence of this state, even to a slight extent.

After the wound has healed the surface should be perfectly soft and covered with loose connective tissue, and the impression upon making a digital examination should be very similar to that one obtains in making an examination of a cervix which has not been disturbed by pregnancy or confinement.

After the operation has been completed the uterus should be replaced in the normal position by bi-manual manipulation. It frequently happens that during operations the uterus has been drawn down considerably, and after the work is completed it is quite out of place, and unless the surgeon takes the precaution of properly replacing the organ at the conclusion of his operation it may remain displaced during the entire time the patient is confined to bed. In this way considerable harm may follow.

The after-treatment consists of rest in bed for at least two weeks; the administration of from three to six large, hot douches a day; a light diet, and the use of mild laxatives.

In almost all of these patients there are other conditions which must be corrected, and the prognosis will be considered in connection with them.

LACERATION OF THE PERINEUM

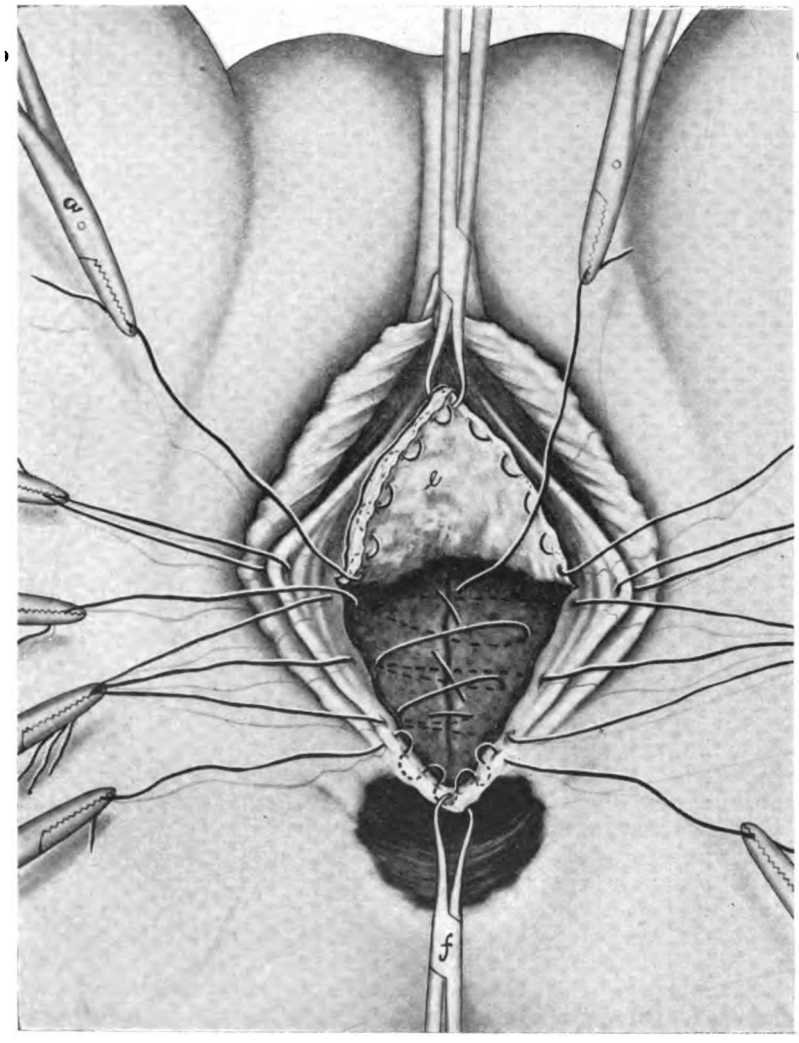
This deformity almost invariably accompanies the condition just described, although if the patient has had the care of a physician during confinement the laceration is nowadays usually repaired at once after its occurrence; consequently there are comparatively few old lacerations now in patients who have this proper attention. These cases belong to a class in which the lacerations occurred at a time when the general practitioner was not so careful to examine and repair a torn perineum after confinement as he is to-day, and in the class still being confined by the midwife.

The history is the same as that just given in connection with laceration of the cervix. The laceration may vary in degree, extending quite into the rectum for a slight distance, or for several inches, or only through a portion of the perineal body, or only through the upper or the lower portion—which may be determined upon inspection or by making a digital examination. There may exist at the same time a bulging forward of the rectum between the margins of the lacerated tissues, the mucous membrane of the vagina and the wall of the rectum being carried forward by the pressure of the feces in the latter, forming a rectocele. If this condition be present it usually interferes very seriously with the evacuation of the bowels.

In some cases the skin and mucous membrane may have remained perfectly intact, and still with virtually no perineal support left, because while the skin and mucous membrane were not injured, on account of their elasticity, the transverse perineal muscles were completely torn and the levator ani muscles separated.

Operative technique. A transverse incision is made through the septum remaining between the rectum and vagina, and the tissues of the vaginal wall carefully dissected loose from those of the rectal wall, forming a large flap, which is carried forward into the vagina—the entire septum being split from side to side. After the incision through the skin and through a short distance of cicatricial tissue which usually exists underneath the skin, the separation of these flaps may be accomplished most readily by grasping the vaginal flap with dissecting forceps and shoving away this section—the posterior flap—

by means of the finger, covered with several layers of moist aseptic gauze. In this manner a flap, as shown in the plate, can be produced in a few moments. This exposes the tissues on each side which originally formed the perineum,



PERINEORRHAPHY.

The recto-vaginal septum has been split and the vaginal flap (e) drawn forward. A silkworm gut suture (aa) has been applied to the anterior flap, which, when tied, will make a new floor for the vagina. A similar suture (b) is applied to the posterior flap. These sutures extend to, but not through, the mucous membrane in either case. The sutures caught in the forceps, marked (c), pass through the lateral flaps, but they are left untied until each successive tissue on either side has been united with the same tissue on the opposite side by means of the continuous cat-gut suture marked (d). After the deep tissues have been united with the silkworm gut sutures (c) are tied.

and by carefully uniting these, after the manner to be described, a perineum may be constructed which will be as thorough a support as the original structure. The anterior flap is drawn forward and a row of interrupted tension sutures applied, as indicated in the plate, the first suture beginning

directly underneath the skin and grasping the submucous tissues successively and issuing on the opposite side directly underneath the skin. The last suture posteriorly is applied precisely in the same manner.

It will be seen that after the first suture has been tied there will be a perfect floor to the vagina, no matter how deep the laceration may have been. The same is true after the last stitch posteriorly has been tied, there will be a new roof for the rectum, even though the laceration may have extended a considerable distance up into the same. It is plain that if these two stitches are properly applied that a recto-vaginal fistula after this operation is impossible.

The remaining deep stitches are inserted through the tissues on each side, beginning near the skin and passing down to a point just in front of the rectum, then passing over to the other side in front of the rectum and out through the tissues precisely opposite to the manner of introduction on the other side. From two to five of these sutures are inserted and left untied. Ordinary catgut sutures would undoubtedly suffice for this purpose, but in our practice we have used chromicized catgut, which will be absorbed after about twenty days. A continuous catgut suture is then introduced, as shown, for the purpose of uniting the tissues on one side to the corresponding tissues on the opposite, a small bite being taken with a short, curved needle and care being exercised to avoid wounding the rectum.

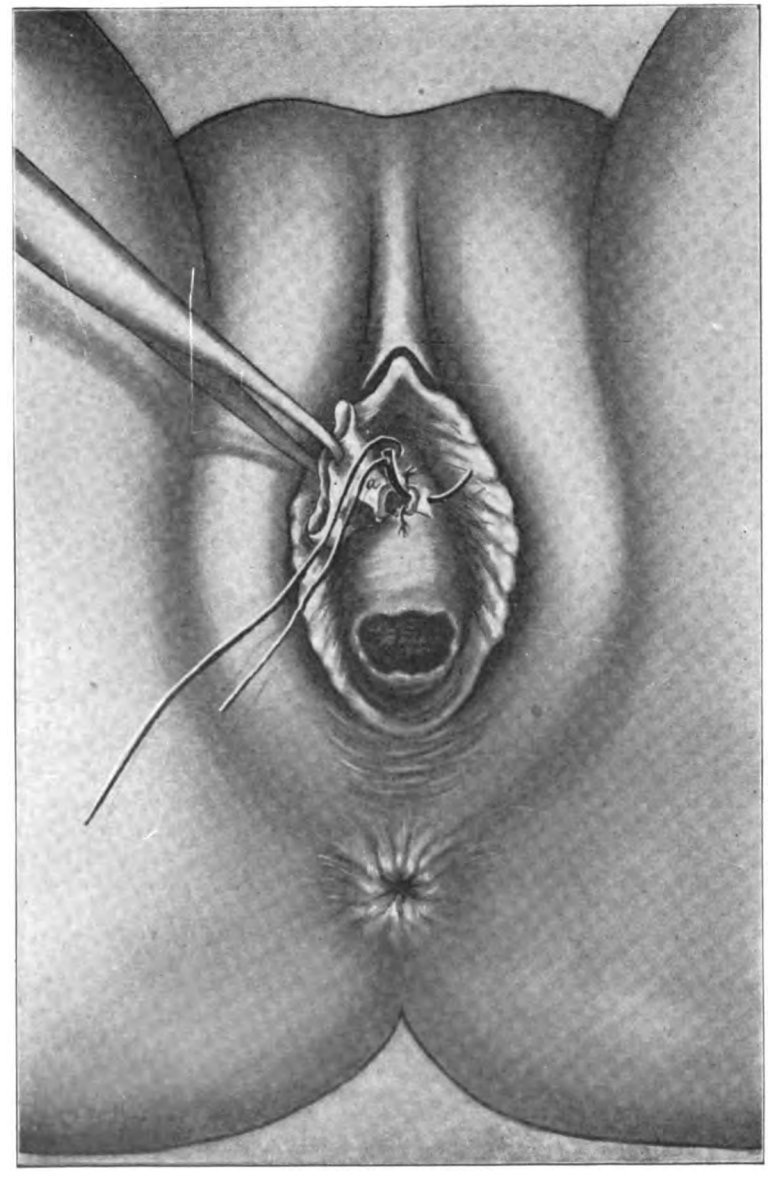
It is important, again, to draw these stitches very loosely, for fear of causing pressure-necrosis. The suturing can be done from above downward, then from below upward, then from above downward again, the same suture being used continuously.

After all the tissues have been placed in accurate coaptation in this manner, the continuous suture is tied and then the stay sutures are tied loosely over this, and then the skin is united carefully with a continuous catgut suture. It is clear that a rectocele cannot occur after this operation, because the space originally occupied by the rectocele is completely filled in by the sutures. This operation will give satisfactory results with any one of the various forms of laceration of the perineum enumerated above.

Concomitant hemorrhoids. A considerable number of these patients suffer at the same time from hemorrhoids. It is usually sufficient simply to dilate the sphincter ani muscles thoroughly before this operation is performed, in order to relieve the patient of that trouble. In cases where there are hemorrhoids of considerable size, however, the operation already described should be employed, but the hemorrhoids on the anterior surface of the rectum should not be disturbed for fear of causing an infection of the perineal wound. In case a hemorrhoidal swelling is directly on the anterior surface of the rectum, this invariably disappears after the perineum has been repaired, which is not always the case with those located on the lateral or the posterior surfaces of the rectum, hence the latter should be removed with clamp and cautery, or with the ligature.

After-treatment. The patient should remain in bed for at least two weeks, and if possible it is better to have her remain a week or two longer, because the benefit derived from perfect rest is quite important, and if this be prolonged somewhat it is quite worth while. Many of these patients also suffer from gastric disturbances; consequently they are greatly benefited by careful dieting, which may be carried out during their stay in the hospital without interfering with the progress of the recovery from the operation. We have found that many suffer at the same time from an inability to masticate their food properly, because during their long-continued illness they have not given needful attention to the preservation of the teeth. Among the class of working women in whom these operations are especially indicated one frequently finds the mouth filled with decayed roots, and it is consequently a good plan

invariably to examine the teeth and during the anesthesia remove any decayed roots that may be present, and to direct these patients after recovery from



EXCISION OF URETHRA.

The urethra has been dissected out and drawn forward with forceps and partly severed. The remaining stump is being sutured to the skin with interrupted cat-gut sutures, two sutures being in place and the third one being applied.

their operations to have the remaining teeth thoroughly repaired, and if there are many missing to procure artificial dentures. This will also aid in building up these sufferers very greatly after the return home from their operations.

These patients should be especially cautioned against constipation, as this will aid greatly in securing a satisfactory recovery. If these various precautions are taken the prognosis is usually very satisfactory. A worn-out woman between the age of thirty-five and forty-five years usually recovers to such an extent that within a year or two she will readily be taken to be five or ten years younger than she was before the operation.

In many of these cases there is at the same time a retroversion or retroflexion of the uterus, which may easily be corrected by making bimanual manipulations, but in which the uterus will not maintain its corrected position for any considerable length of time.

Both of the operations which have just been described must usually be performed on the same patient. The result of the amputation of the cervix will be primarily to remove an amount of irritating cicatricial tissue, to remove a suppurating ulcerated surface, and this in turn will result in the natural absorption of the hypertrophy of the uterus, which is present at the time of the operation. Within a few months an hypertrophied uterus upon which this operation has been performed will usually be reduced to an almost normal size. This in itself will increase the probability of the organ remaining in its normal position. Then, further, the repair of the perineum will increase this likelihood still more, by supplying additional support for the uterus. If, however, the retroversion or retroflexion persists after these operations or if the tendency to these displacements is so great that it does not seem likely that they will be corrected by means of these two operations, then a third procedure is indicated for the direct relief of this condition.

ALEXANDER OPERATION

In cases in which this tendency to retroversion and retroflexion exists the round ligaments which normally hold the uterus forward have been so severely stretched that they are no longer able to furnish normal support.

An incision three centimeters in length is made directly over the external abdominal ring in the direction of the inguinal canal. It is carried down through the skin and deep fascia to the fascia of the external oblique abdominal muscle. It is important that this incision be carried quite through the deep fascia, because if any portion of this fascia is permitted to remain undivided the surgeon may experience considerable difficulty in locating the round ligament.

After the fascia of the external oblique has been thoroughly exposed, the external abdominal ring can be located by palpation, as it gives the feeling of less resistance at this point than at any other. The fascia of the external oblique is now split in the direction of its fibers at this point, which will expose a small mass of fat directly in the external abdominal ring. If this mass of fat is now grasped by means of a pair of hemostatic forceps, it will contain the round ligament, which may appear as a thread-like band, or may take the form of a cord of considerable size, sometimes as large as two millimeters in diameter. It is important to dissect this out carefully, because if once lost it may be difficult to find it again. This ligament should be examined carefully, and the genital branch of the genito-crural nerve which accompanies it should be separated as its destruction results in a paralysis of sensation in the parts to which it is supplied—which is likely to be the cause of considerable annoyance.

After the round ligament has been freed from its connective tissue attachments, it should be drawn up very gently until the infundibuliform process of the peritoneum becomes apparent. The ligament is then drawn out until

it gives the sensation of drawing the uterus against the abdominal wall. Then a pad of sterile gauze is passed through under the ligament and the same steps are carried out on the opposite side. After both ligaments have been loosened and drawn up until this sensation of pulling the uterus against the abdominal wall is felt on each side, then each is relaxed for a distance of about two or three centimeters, in order to give the uterus the desired mobility, and a few stitches of fine chromicized catgut are passed through each ligament, doubled upon itself in order to remove the slack in the ligament. Then a few stitches are inserted between the doubled ligament and the posterior surface of the fascia of the external oblique.

In case the inguinal canal has been stretched during the operation, the pillars of the canal are drawn together by a few stitches. The suturing of the fascia of the external oblique abdominal muscle completes the operation.

Much has been written concerning the likelihood of suppuration taking place in these operations. We believe that this is due to the fact that a considerable portion of the operation is performed upon tissues having slight vitality, and if with these the surgeon has a tendency to tie his sutures too tight the resulting pressure necrosis will supply an excellent culture medium for the micro-organisms. If the sutures are tied just tightly enough to secure coaptation, and not enough to cause pressure-necrosis, there is no proneness towards suppuration.

After-treatment. If this operation is performed in connection with the last two just described, no special after-treatment will be required. If it is done for the relief of retroversion or retroflexion of the uterus in cases in which there is no indication for the other two operations, then it is wise for the patient to wear a carefully-fitted pessary for at least two months afterwards, so that the adhesions between the round ligaments and their new attachments will have become perfectly firm before any weight is placed upon them.

Prognosis. If this operation is undertaken only in proper cases, namely, in those in which no force whatever is required in replacing the uterus into its normal position, cases in which the uterus can be retained in its normal position by means of a carefully-applied pessary, the prognosis is almost invariably good. Then the operation does not interfere with a future pregnancy, and after delivery the uterus will maintain a normal position, showing that the changes during pregnancy have no tendency to destroy the benefits secured for the patient by this operation. It is important, we believe, that the uterus should be placed in the normal position by bi-manual manipulation before this operation is done. It also seems important that the round ligaments should not be shortened too much, in order to permit the normal mobility of the uterus.

VESICOCELE

In this same class of cases, as has been stated above, there is also frequently an injury to the anterior vaginal wall, as well as to the posterior, consisting in a separation of the tissues supporting the bladder posteriorly. As a result of this injury the bladder will bulge into the vagina more and more, so that in extreme cases it may project in a sac-like protrusion from the vagina. This will result in retention of a certain amount of urine, in obstruction to the passage of urine, and as infection of this residual urine is likely to occur this condition usually results in the production of a cystitis. If this affection is present only to a very slight extent, the operation just described for the repair of a laceration of the perineum will usually suffice to support the bladder

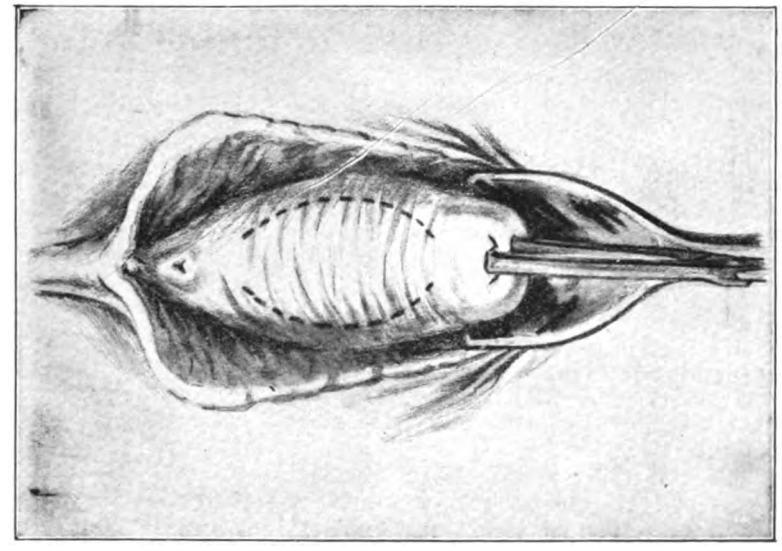


Fig. 2

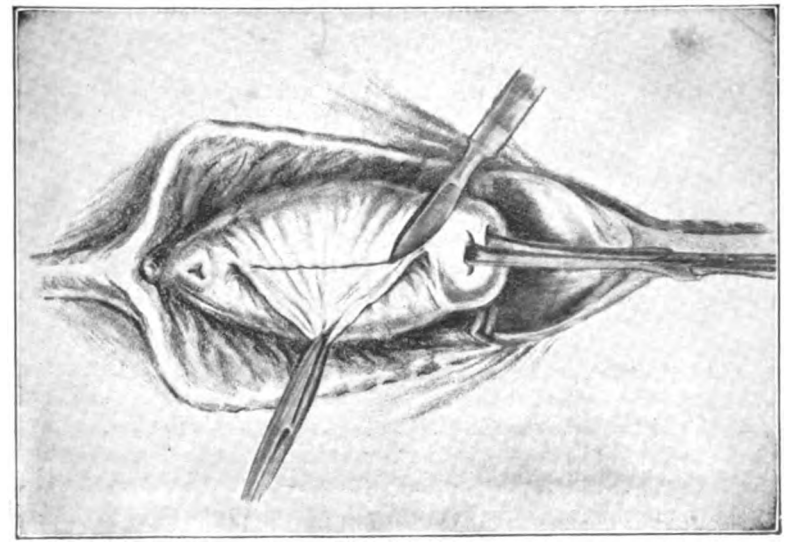


Fig. 1.

OPERATION FOR RELIEF OF CYSTOCELE ACCORDING TO METHOD OF DR. DAVID 'TOD GILLIAM.

Fig. 1. The dotted line shows the outline of the area to be denuded.
Fig. 2. Incision at base of fold of redundant tissue which separates the area to be denuded from the flap. [See following page.]

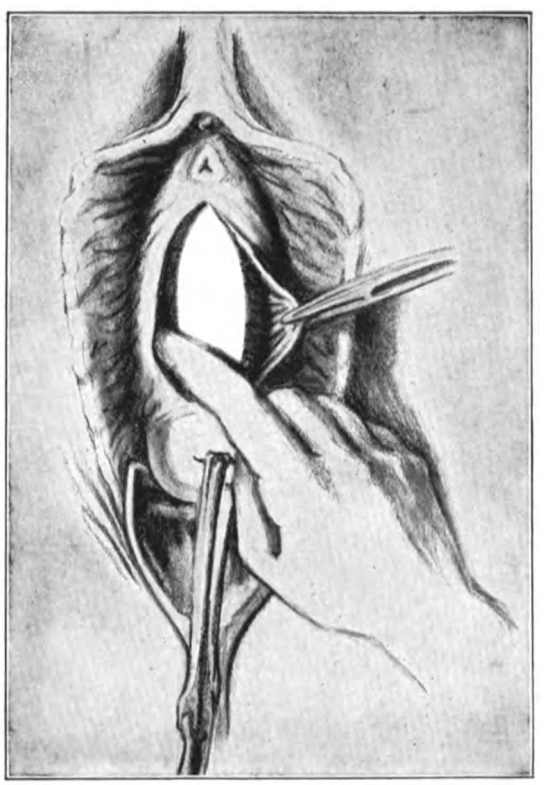


Fig. 3.

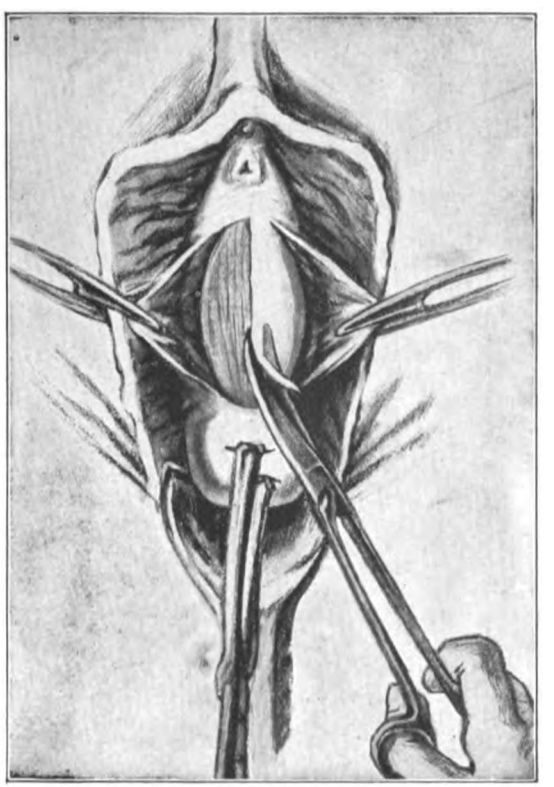


Fig. 4.

Fig. 3. Forming flaps on either side to cover defect caused by denuding area as shown in Fig. 4.

Fig. 4. Denuding central area over which the lateral flaps are to be drawn and sutured. It is important in this operation, in uniting the lateral flaps, to place the sutures deeply enough to grasp thoroughly the layer of submucous connective tissue.

It is also important for securing a permanent result to place a retention catheter in the bladder for a period of ten to fifteen days, in order to prevent stretching of the newly formed scar tissue.

posteriorly, and as a consequence the symptoms resulting from the vesicocele will subside. If the vesicocele is pronounced, however, this operation alone will not suffice. It will then become necessary to excise an elliptical portion of the anterior vaginal wall, with its greater diameter extending parallel with the direction of the vagina. This will expose the ends of the torn tissues. The latter may be united by a continuous suture extending parallel with the direction of the vagina. If the lacerated tissues are thus united the mucous membrane of the bladder will contract and the vesicocele be abolished. It is important, however, that there be no pressure upon the sutures shortly after the operation, and in order to prevent this it is wise to insert a retention catheter directly after the operation, which will insure an empty bladder, and consequently absence of pressure upon the sutured wound. The perineum should be sutured simultaneously, in order to further support the posterior wall of the bladder.

After-treatment. The patient should be given large quantities of pure water to drink so as to dilute the urine and make it non-irritating, and prevent the accumulation of phosphates in the catheter. A large, hot douche should be given from three to six times a day to keep the vaginal wound clean. In all other respects the after-treatment is the same as following the operations just described.

The retention catheter is removed at the end of one and one-half or two weeks, but if there is any tendency of the bladder to become sufficiently distended to stretch the wound the catheter should be reintroduced.

Prognosis. The prognosis after this operation is satisfactory unless the deformity has existed for so long a time that the elasticity of the mucous membrane of the bladder has been destroyed.

EXCISION OF THE LABIA MAJORA, MINORA AND CLITORIS FOR CARCINOMA

In carcinoma of any one of these parts, the excision of the entire part, together with a considerable portion of the surrounding tissues, is indicated, but the most important portion of the treatment to be carried out consists in the careful dissection of the inguinal lymphatic glands, an operation which has been described in connection with carcinoma of the penis.

In our own work we have employed the electro-cautery or the Pacquelin cautery for the removal of these growths, with the hope of preventing the inoculation of surrounding tissues that would, or might, follow the knife. In all of these cases it is important to dissect away the fat and lymph nodes of the inguinal regions, making use of the gauze dissection because in this way recurrence can often be prevented.

Prognosis. A very extensive and thorough operation done early before the disease has progressed far, promises well for a permanent recovery, which is not the case when the disease is greatly advanced. It is most important to make a very extensive operation when the patient first comes under the care of the surgeon, even though the area involved be very small.

EXCISION OF THE URETHRA

This operation may be indicated for the relief of epithelioma of the meatus, a condition not very uncommon, or for a prolapsus of the urethra. If it is performed for the relief of epithelioma the same precautions must be observed as in operations for the relief of epithelioma elsewhere. A sufficient amount of tissue must be removed to insure the greatest possible freedom from recurrence.

Technique. A circular incision is made around the urethra for a sufficient distance to remove all diseased tissues. Then the urethra is dissected out upwards towards the bladder until a point is reached a sufficient distance from the disease; then the remnant of the canal is drawn forward and a stitch applied between this and the outer skin. The urethra is then partly cut off transversely and a second stitch applied a short distance from the first. In this manner the urethra is successively stitched to the skin and cut off until the entire structure has been severed. In this, as in every operation in which a tubular structure has to be brought foward and attached to the skin, it is best to apply a few stay sutures through the wall of the tube at some distance back from the outer end, and to attach these stitches to the outer structures, so that but little tension is left for the stitches, which are applied immediately through the end of the tube and through the skin. In this manner there is much less danger of retraction from the tube and consequent constriction of its end than if simply a single row of sutures is employed.

Should it seem difficult to introduce a catheter through the opening for the purpose of emptying the bladder from time to time a small retention catheter may be passed while the patient is still anesthetized. This catheter is removed after a few days and the patient is usually able thereafter to empty the bladder spontaneously.

The after-treatment is the same as in operation for cystocele.

VESICO-VAGINAL FISTULA

Patients suffering from this condition usually give a history of a long continued labor with or without the use of forceps. Following there has usually been retention of urine, and after this incontinence. It is rare that a leakage occurs directly after the delivery, indicating that a rupture of the bladder has taken place at that time. In most instances the bladder wall is crushed only sufficient to become gangrenous after a time, but will support the urine for several days after the confinement.

Prophylaxis. At this point it might be well to state that in these cases the formation of the fistula might frequently be prevented if, directly after a delivery in which an unusual amount of pressure occurred, the conditions were made favorable for the restoration of the normal vitality of the crushed tissues. This would be greatly assisted by the introduction of the retention catheter, which would keep the bladder constantly empty and consequently improve the circulatory conditions in this organ by removing the intra-vesical pressure. If, however, a portion of the posterior bladder wall and the anterior vaginal wall have sloughed away so that a vesico-vaginal fistula has occurred nearly at the time at which the patient comes under treatment, relief must come from repair operation, unless the fistula be very small, in which case simple continuous drainage of the bladder will result in a healing of the opening.

Technique. If the fistula be moderate in size it is necessary only to bring in coaptation relatively broad surfaces in order to secure a closure of the aperture. This can be accomplished by splitting the edge of the fistula in its entire circumference, then applying a row of fine catgut sutures to the mucous membrane, in order not to permit any portion of the suture to project into the bladder. A second row of sutures is applied to the connective tissue layer between the vesical and the vaginal mucous membrane. A third row of sutures is then applied to the vaginal mucous membrane. The bladder is then drained with a retention catheter and the after-treatment carried out as described in the operation for vesicocele.

Prognosis. If the fistula be moderate in size the prognosis is almost invariably good. If, however, it is large the closure must be accomplished by plastic

operations, portions of the mucous membrane being taken from various parts apparently most suited for that purpose, but if the entire posterior wall of the bladder has been destroyed its repair will require a great amount of skill in plastic surgery.

During the past few years since the introduction of very extensive operations for the relief of carcinoma of the cervix uteri in connection with vaginal hysterectomy we have encountered a number of patients with post-operative vesico-vaginal fistulæ. Usually these will heal after the operation described above, but occasionally such a case fails to heal completely after several operations. In such instances it is best to open the abdominal cavity by a low, middle incision, separate the bladder wall from the scar tissue, being careful not to injure the ureters which may have been drawn toward the median line by cicatricial contraction. When the fistula has been exposed an area with a diameter of two to four cm. is denuded and the fistula is closed by folding in the edges of the bladder with three rows of fine, chromic catgut sutures. The peritoneal cavity is drained through the vaginal opening by means of a strand of gauze. The abdominal cavity is closed and a retention catheter is placed in the bladder. The patient receives a glass of distilled water and five drops of dilute aromatic sulphuric acid every one to two hours to prevent the formation of phosphates in the bladder or the retention catheter, which is removed about the tenth day. The results are very satisfactory.

RECTO-VAGINAL FISTULA

This condition is produced either by the opening of an abscess in the recto-vaginal septum into both the vagina and the rectum simultaneously, or by the causes which have been mentioned in connection with vesico-vaginal fistula. The operation for its relief is virtually the same as that for vesico-vaginal fistula, with the addition of a very thorough dilatation of the sphincter ani muscles so as to prevent pressure of the wound from the side of the rectum due to the retention of fecal material on account of a tightly constricted sphincter. The after-treatment in these cases is the same as that just described.

CYSTS OF BARTHOLIN'S GLANDS

The occlusion of the ducts of Bartholin's glands, causing cysts, is of rather common occurrence, and the result of such occlusion is the same as of the ducts of other glands. An accumulation of the mucus secreted by the gland occurs within the ducts, causing a distension which may increase to such an extent as to give rise to great inconvenience and sometimes to pain. The location of these cysts makes their infection quite likely, and consequently suppurating cysts of the glands of Bartholin is not an uncommon complication. This is especially true of patients who have suffered from gonorrheal infection. These suppurating cysts may open spontaneously, and this may result in a spontaneous cure or in the formation of a fistula or recurrent abscesses.

Treatment. The treatment may consist in a simple puncture of the cyst, but this will usually result only in temporary benefit, and is consequently unjustifiable, except where the patient must have immediate relief and cannot possibly subject herself to a radical operation, consisting in the excision of the entire cyst. For permanent relief an incision is made over the most prominent portion of the cyst, which is then dissected out from the surrounding tissues. With care it is possible to obtain the line of cleavage between the cyst wall and the surrounding tissues, and with a careful dissection the entire tumor can usually be excised without rupture. The space occupied by the

cyst is then closed by means of a few buried sutures of catgut and a row of sutures uniting the mucous membrane, and the ordinary dressing applied.

DYSMENORRHEA DUE TO ATRESIA OF THE CERVIX

In by far the greater number of patients suffering from dysmenorrhea the cause lies in the results of inflammatory conditions above the uterus. In considering appendicitis this subject was discussed, and again in speaking of pyosalpinx, but there is a certain number of cases in which none of the inflammatory conditions affecting the tubes and ovaries are present and in which the cause of the dysmenorrhea lies in an atresia of the cervix, or in a mechanical obstruction due to a short bend of the body of the uterus upon the cervix, or in an inflammatory condition of the mucous lining of the uterus and cervix. In these patients the trouble may be relieved by thorough dilatation of the cervix, repeated a number of times. The dilatation may best be started by inserting ordinary male urethral steel sounds, beginning with a size sufficiently small to enter the contracted cervix and increasing gradually until the largest size is reached; then introducing a uterine dilator and stretching the cervix as much as it will bear without tearing. The dilator should be left in position under tension, then relaxed, then dilated again—and this repeated many times until the canal remains comparatively wide open after the dilator has been removed. If there is a sharp angle between the cervix and the uterus it is well to dilate the cervix as much as possible without causing any laceration, and then insert a tenotome and transversely cut the ridge opposite the junction between the body of the uterus and the cervix. In case there has been an endometritis which has resulted in the formation of granulation tissue within the uterus and the cervical canal this should be thoroughly curetted away with a moderately blunt curette and then sponged with aseptic gauze. The uterine cavity should afterwards be tamponed with a piece of aseptic gauze moistened with ninety-five per cent. solution of carbolic acid. This should be left in place from two to five minutes and then withdrawn. Then the cavity should be tamponed with a piece of gauze saturated with strong alcohol. After this has been removed a piece of iodoform gauze may be carried up into the uterus in order to serve as a capillary drain. More recently we have invariably tamponed the uterus with gauze saturated with Beck's bismuth paste. This tampon is left in position for from two to three days.

After-treatment. The patient should be kept in bed for from one to two weeks and receive from three to six large, hot douches every day, in order to relieve the congestion resulting from the operation. During the subsequent menstrual periods the patient should receive a mild uterine sedative during each period for a number of months. Patients suffering from this condition are likely to expect pain, and unless some sedative is given a slight amount of pain may be exaggerated by their nervous condition into a serious degree of suffering. On the contrary, if a uterine sedative is given, the patient will be entirely free from distress and consequently soon cease looking for pain during these periods.

The prognosis will depend upon the cause of the dysmenorrhea. If the cause was entirely in the cervix or in the uterus a very satisfactory result may be expected. If, however, it was in the tubes and ovaries, then the result will be entirely negative.

PART X

SURGERY OF THE EXTREMITIES

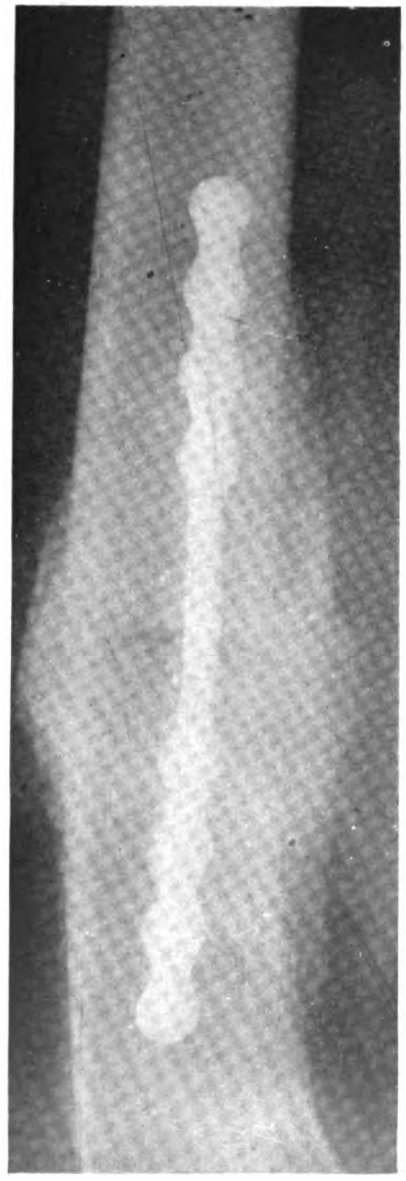
OPERATIONS FOR THE RELIEF OF FRACTURES

The scope of this work does not comprehend the treatment of fractures, except those in which operative interference is indicated. At the outset we wish to state that operative intervention is not indicated in any form of fracture unless the operator absolutely controls the conditions of asepsis during the operation, because an infection is so much more serious than the fracture itself that if this cannot be thoroughly eliminated an incisional operation is, of course, not indicated.

Anatomic and functional results. In the past it has generally been accepted that shortenings of from one-half to one inch in fractures of the femur, and in oblique fractures of the tibia and fibula, are satisfactory results. To-day, not only are surgeons striving to obtain better results but the public demands better consequences, both as to function and deformity following the treatment of a broken bone. The X-ray undoubtedly has had a great deal to do with bringing this about. It must not be forgotten that the finality of our treatment, whether operative or not, is likely to be tested by radiography, and if the fragments are shown not to be in accurate apposition, the patient is likely to think that the surgeon has not exercised proper skill in the management of his case. This impression is especially apt to be conveyed if there is some loss of function besides the anatomic defect. As to the ultimate functional result, the shortening is not of so much importance as the rotary or angular deformity which usually accompanies the shortening in fractures of the femur.

In deciding as to whether any particular fracture should be operated upon, or should be treated by splints, plaster-of-Paris or extension, etc., the importance or not of restoring the bones to their normal form should be the first consideration.

In any given case in which, from the location of the fracture, or after considering the occupation of the patient, it seems important to restore the bone to its normal form, the next important thing to consider is, how can we secure an accurate apposition of the fractured ends with good alignment, and be able to hold them in this position with a reasonable degree of certainty. In a large proportion of simple fractures, the surgeon may, after careful examination, feel fairly sure that he can secure the above conditions by some of the ordinary means at his command; and in such cases there certainly is no indication for operative treatment. On the other hand, there are many fractures in which, after careful examination, the surgeon feels that he cannot hold the fragments in accurate apposition with any degree of certainty by the ordinary methods of treatment. In this class of cases, it is well to consider the open method of exposing the fragments by a formal dissection and securing an accurate apposition by dovetailing the parts into their normal position, which will do away with all rotary displacement and be the first step toward a proper alignment.



Malunited fracture of upper third of femur with a plate and eight screws. Picture eight months after operation.

Fracture of surgical neck of humerus nailed three weeks after accident. Picture two weeks after operation.

Old ununited fracture of lower third of humerus, three years' duration. Picture three and one-half years after operation.

Oblique fracture middle of tibia and transverse of fibula. Picture seven months after operation.

Operative devices to secure fixation. There are several methods of open operations at our command, such as wiring the ends of the bone, the introduction of intermedullary bone grafts, or bone inlays, the use of the Parkhill's screws and clamp, the use of the steel nails or bone or ivory pegs, and the use of the Lane plates. Of the various methods in foreign material used as a means of fixation, the Lane plates seem to be the best method by which to actually hold the fragments in all directions and at the same time leave no communication with the skin to predispose to infection. The Lane method consists of cutting down upon a fracture, bringing the broken bones into accurate apposition, and fixing in this position by the application of high-grade, cold-rolled, steel plates. The plates are provided with from two to ten reinforced screw holes, arranged in series of one, two, three, four and five at each end, according to the size and strength of the plate. The plate is held in place by the introduction of steel screws which are threaded up to their heads.

One must remember that there is a varying degree of risk connected with this operation, and this danger must be taken into consideration. The chief difficulty is, that when a foreign body is left in the tissues, the surgeon must be infinitely more careful of his asepsis than in ordinary surgical procedures. A laparotomy is a simple matter compared to the open treatment of a fracture. The peritoneum is our friend and will take care of a great many microbes if we treat it kindly, but bones and the tissues about them will not. It is because of insufficient aseptic precautions that we hear of rarefying osteitis taking place about wire and screws. It is for this same reason that sinuses and the other more serious complications develop in these wounds after operation.

Unfortunately many bad results have followed the use of steel plates, and as a result, the Lane method has suffered from much unjust criticism. There are many cases which were plated two years ago who are suffering today from complications that arose at the time of, or following, the operation, wherein there is a necrosis of the ends of the bone with a consequent non-union, or the patient still has an infected bone with a chronic osteomyelitis, or has a stiffened, greatly-impaired extremity as a result of the wide-spread, purulent infiltration of the soft parts. Even after seeing these bad results one should not condemn the method until he has stopped to consider why these various complications followed the plating.

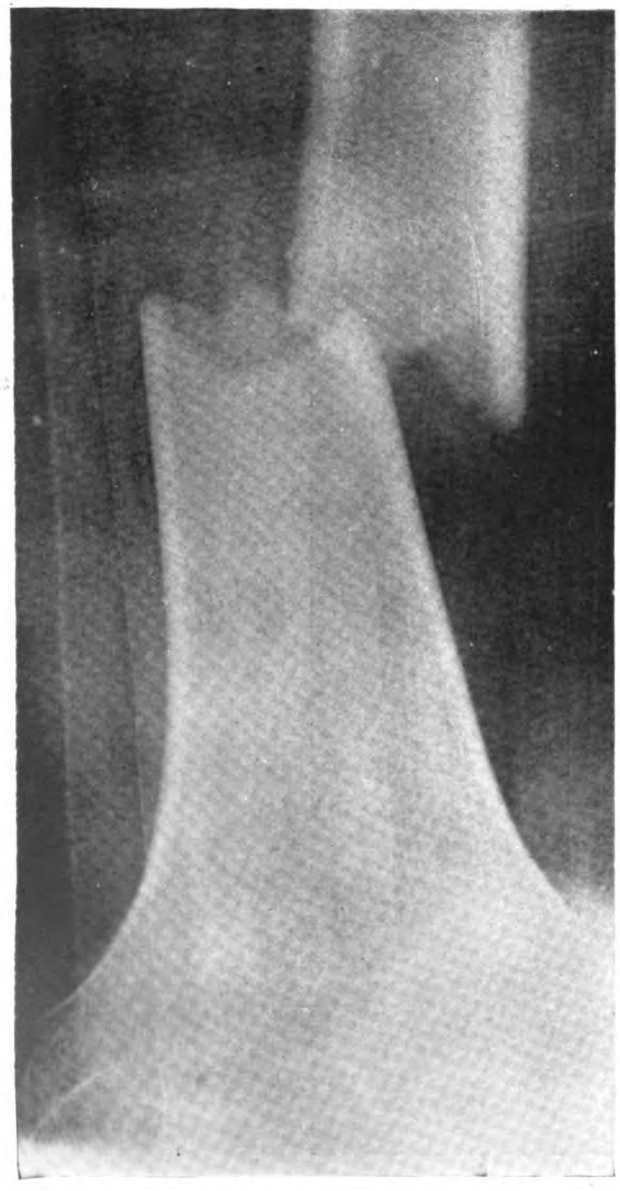
It is evident that Mr. Lane and several other surgeons have demonstrated beyond a doubt that foreign bodies, such as steel plates, can be fastened to bones and left in place permanently without causing any irritation whatsoever, and that the majority of the various complications that do follow their use are caused by the introduction of infection at the time of operation.

During the past eight years it has been the practice of the authors to operate upon all simple fractures of long bones in which we were unable to restore the normal relationship of the fragments by ordinary means, and in laboring people in whom it was important that their mechanics should not be impaired. In the majority of these cases we have used the method of Mr. Lane, of London, which consists, as before stated, in the application of steel plates to keep the fragments in place. We have found that this method of treatment in simple fractures possesses all of the advantages to the patient, claimed for it by Mr. Lane, which are as follows:

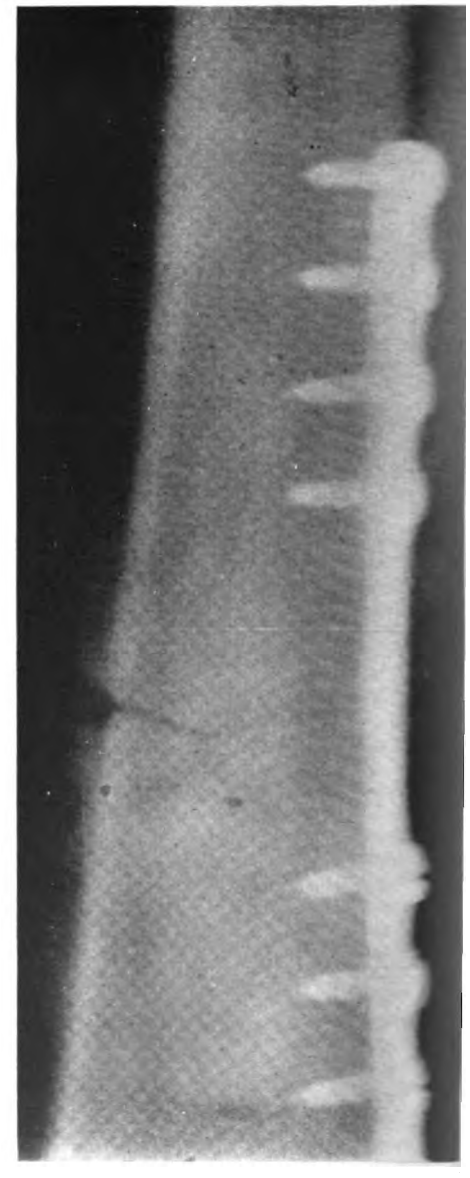
1. The patient is at once relieved of the pain of any movement of the fragments upon one another.

2. He is freed from the tension and discomfort due to the extensive extravasation of blood between and into the tissues.

Ununited fracture ulna and radius, seven months' duration. Picture two years after operation, apparent non-union of ulna, but perfect functional result.



Transverse fracture of lower end of femur. See following plate.



Same case as preceding after application of one steel plate.

3. It shortens the duration of the period during which he is incapacitated from work, since union is practically by first intention, and consequently very rapid and perfect.

4. Lastly, and by far the most important, they leave the skeletal mechanics in the condition in which they were before the sustained injury.

This treatment is especially indicated in fractures of the shaft of the humerus and the femur, for in the majority of cases one cannot hold the fragments in accurate apposition with any degree of certainty without operative measures.

This method of treatment should not be used except in a well-regulated hospital where the surgeon can be absolutely certain that every detail of the operation will be carried on in an aseptic manner.

Time of operation. In the majority of simple fractures it has been our practice to operate immediately if the patient comes under our care during the first day or two. The bones are much easier to adjust at this time before muscular contraction has taken place. Occasionally when a fracture comes under observation on the third or fourth day, and there is considerable swelling of the tissues, we prefer to wait three or four days longer until the circulation in the surrounding tissues has improved. So far as we have been able to observe the cases operated upon the first day have done just as well as those operated after a week or ten days have elapsed.

A rigid technique is necessary. 1. The skin in the region of the fracture is very thoroughly disinfected, and an incision is made through it and superficial fascia at a point from which the fragments may be reached with a minimum damage to the soft parts. The skin in the field of operation should now be excluded from the wound by attaching sterile gauze pads to the divided margin of the skin by means of forceps devised for this purpose.

2. It is important that asepsis be carried out to the most extreme degree, and this can be done only by doing the entire operation with instruments and not allowing the operator's gloved fingers to come in contact with any portion of the wound. Also it is important that no instrument or sponge come in contact with any other object after coming from the sterilizer. This can be accomplished by placing all of the instruments to be used in the operation in the tray in which the instruments are sterilized, and then bringing the tray directly from the sterilizer to the instrument table, and using the instruments directly from this tray.

The sponges to be used are taken by a pair of forceps from a package of sponges which has not been opened since coming from the sterilizer. Thus the sponges and the instruments come direct to the operator without passing through any other hands.

3. If blood clots are present they should be removed from the wound.

4. All hemorrhage should be controlled by applying large hemostatic forceps so that by the time the operation is completed the forceps can be removed without applying any ligatures.

5. Accurate apposition of the fragments should be secured, and this can be easily accomplished by grasping each fragment with a pair of heavy, bone-holding forceps devised especially for this purpose.

6. The periosteum should not be injured, and should be left in its normal position, the plate being applied over the periosteum.

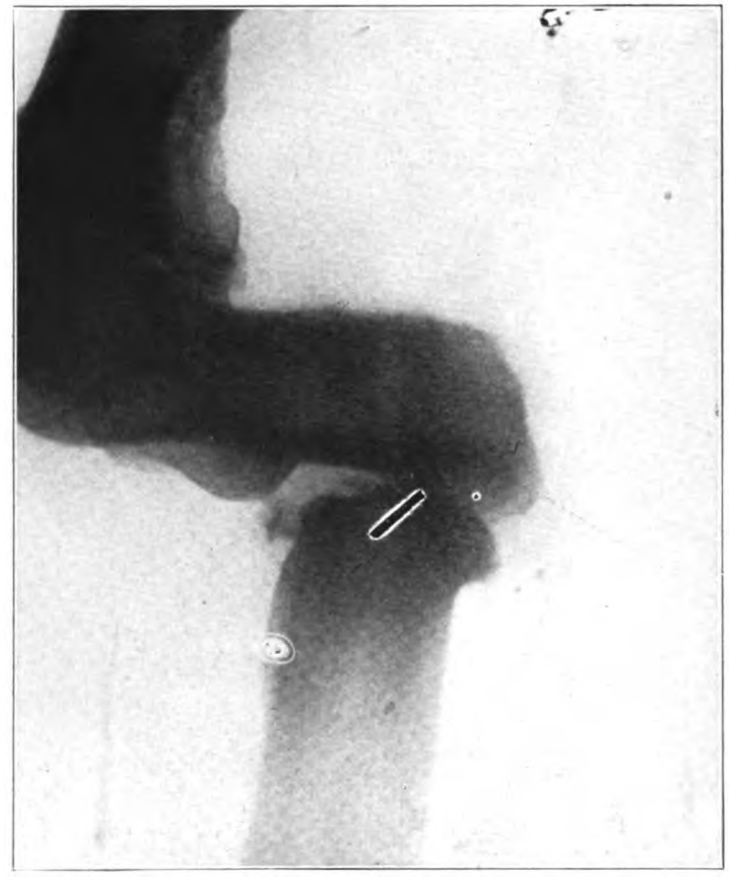
7. The size of the plate to be used should be selected according to the strain that is likely to be placed upon it. One or more plates are applied to

Fracture of neck of femur through which has been driven two nails.

Oblique fracture of femur extending from greater to lesser trochanter. Picture eighteen months after operation.

the bone, depending upon the degree of security desired. It is well to plate securely in the region of the knee-joint so that the knee may be manipulated during convalescence without endangering the holding of the plates. A plate should never be placed subcutaneously if it is possible to cover it up with muscle, but when it is necessary to do so the incision should be made a considerable distance from the location of the plate.

8. A hole should be drilled for introducing the screws and it is important



X-ray of an ununited fracture of the humerus of ten years' standing. Elbow is at angle of 90° and the lower fragment of humerus is at right angle to shaft of humerus.

that the size of the hole be just a little smaller than the screw so that the screw will fit tightly. Enough screws should be introduced to hold the plate very firmly.

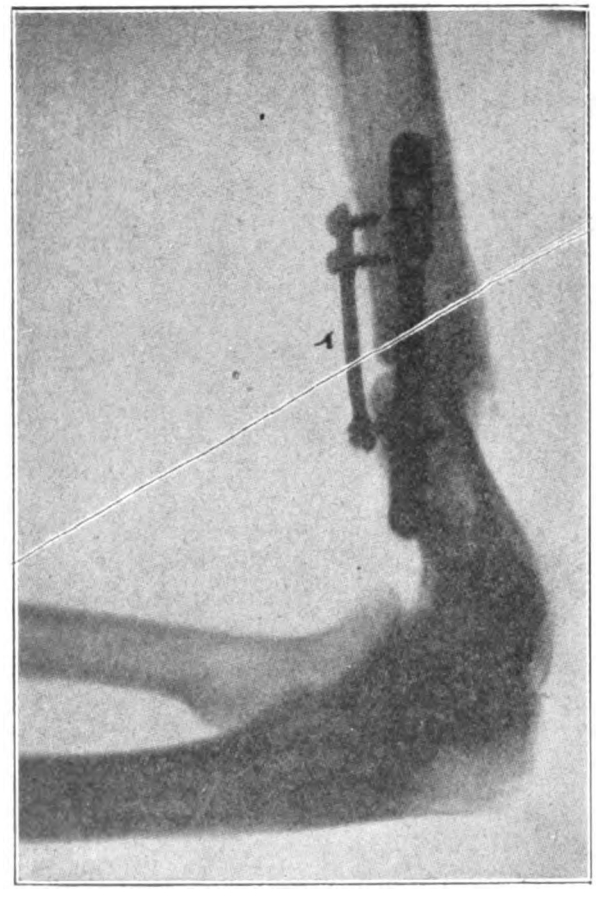
The wound is closed by allowing the muscles to fall together and simply suturing the fascia and skin and not introducing any catgut deep into the wound in the region of the plates.

It is important to secure a very accurate apposition of the skin either by horsehair or metal clips, so that there will be perfect union by first intention, doing away with any possibility of infection coming from the skin. Drainage should never be used.

9. A plain, sterile dressing should be applied and the extremity should be immobilized, either by splints or plaster-of-Paris, so that unnecessary strain will not be placed upon the plates.

Immobilization should be continued the same length of time as if the plates had not been used.

Removal of plates. If a plate has been placed subcutaneously and causes any annoyance it should be removed as soon as union has taken place. Plates



Same case as shown in preceding illustration, showing Lane plate in place.

placed so that they are covered with muscle will seldom have to be removed if they have been introduced absolutely aseptic. As surgeons in general increase their technique, both as to manual dexterity and cleanliness, fewer plates will have to be removed.

A plate or screw placed across or through the epiphyseal line should be removed after union has taken place.

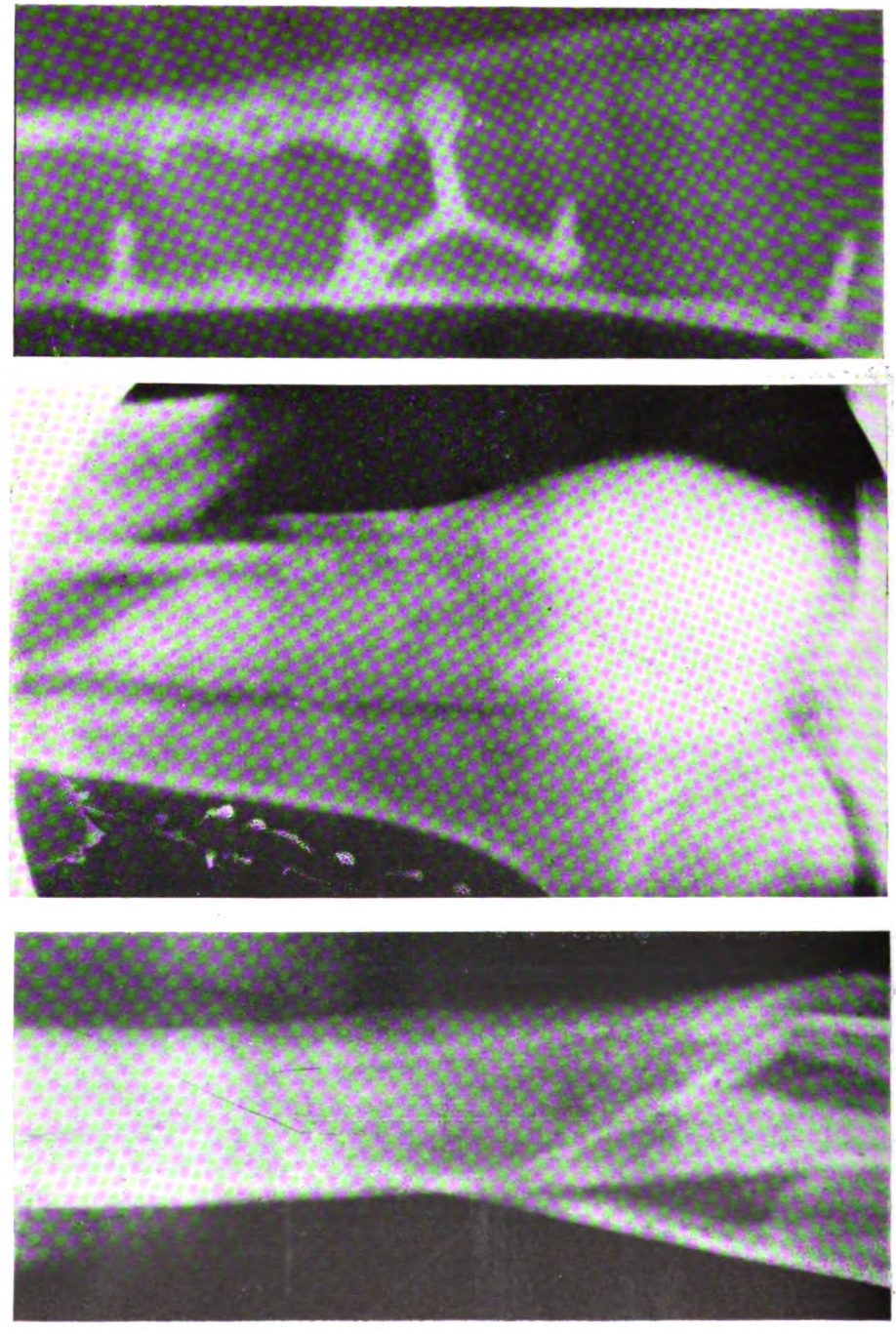
In over two hundred cases of simple fractures operated during the past eight years, the authors have found it necessary to remove plates from eight per cent. of cases.

Old ununited fracture of tibia and fibula in boy eight years of age.

Same case as shown in accompanying illustration. Tibia held in place by two metal plates. Picture six months after operation.

Ununited fracture of lower end of tibia and fibula. Two metal plates at right angles to each other on the tibia. Picture six months after operation.

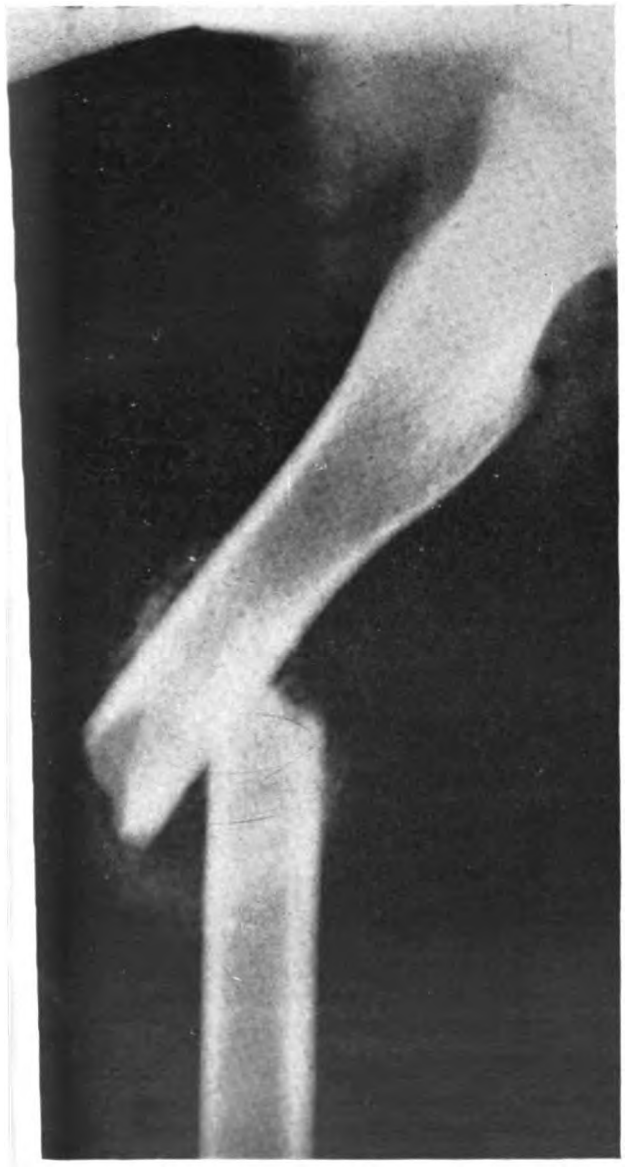
Oblique fracture upper third of tibia. Transverse fracture fibula. One plate on tibia. Picture seven months after operation.



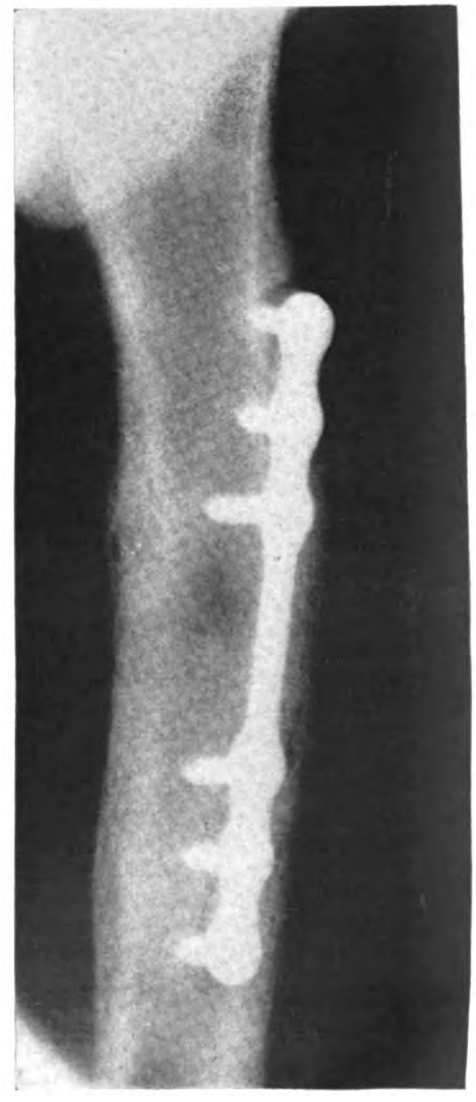
C. Same as A and B with three plates in place showing perfect apposition of fragments.

B.

A. Comminuted fracture of lower third of femur, showing splinter into joint.



Femur fractured four weeks before admission. Age of patient seven years.



Same case seven months after plate was applied.

FIXATION OF FRACTURES BY BONE GRAFT

At the present time many surgeons are giving up the use of foreign material as a means of fixation for fractures and substituting the autogenous bone graft. This has the one definite advantage of not placing a foreign body in the tissues. In the majority of fractures which require operation, a bone graft can be easily introduced and will give sufficient fixation to ensure an excellent result. On the other hand, one often meets with fractures of the tibia and femur, especially, in which a steel plate will give a better fixation and can be introduced with greater ease than a bone graft. In such cases the use of the plate should be the method of choice. There are two methods of fixation in using the bone graft, namely, the intra-medullary graft and the bone inlay method. In fractures in which there is no loss of bone, the bone inlay method of Albee is preferable in most cases.

Technique of inlay graft. The bone for the inlay may be taken from the fragments of the broken bone, or from the tibia. In fresh fractures the graft can usually be taken from the fragments, as there has been no impairment of the osteogenetic function of the bone. In old fractures it is usually preferable to secure the graft from the tibia, as a marked rarefaction of the fragments may have taken place, especially in the lower fragment. For this reason, if the graft is taken from the fragments, it should be taken from the upper fragment and slid down into the lower, because more rarefaction is likely to have taken place in the distal than in the proximal fragment.

The skin incision should be a liberal one, in order that the operation may be done with as little trauma to the bone and surrounding tissues as is possible. Trauma not only predisposes to infection, but may have an inhibitory influence to cellular proliferation. If the incision is short, trauma may arise from the strong retraction of the muscles which will be necessary in carrying out the operation. The same degree of asepsis, as previously described in the use of steel plates, should be carried out, as a resulting infection of any of the involved tissues may interfere with a successful result. After the long skin incision has been made, the dissection is carried down through the fascia and muscles to the bone, securing a good exposure of the fragments. All soft tissues from between the fragments should be removed and the ends of the bone placed so as to restore as nearly as possible the normal contour of the bone.

If the inlay graft is to be taken from the tibia, the periosteum on the fragments is incised longitudinally and peeled back to either side, in the form of flaps, from the bone which is to be removed for the purpose of forming a gutter to receive the inlay. If the inlay is to be taken from the proximal fragment, the periosteum from this fragment should not be disturbed, as it is better for the graft to include the periosteum as well as the endosteum and marrow substance.

In cutting the inlay, it is essential that it be of uniform width and the size be such as to fit accurately into the gutter in the bone where it is to be placed. The graft is started by taking a twin saw, adjusted to proper width, and cutting through the periosteum and about one-twentieth of an inch into the bone, then outlining a graft of uniform width throughout its whole length. A single saw is now used continuing these two parallel cuts through into the medullary cavity. The saw is held at such an angle as to cause the cuts to converge in approaching the medullary cavity. The saw should be held at the same angle while cutting the gutter in the fragments which are to receive the graft. The ends of the graft are freed with transverse cuts made by a chisel. The object of the wedge-shaped graft and gutter is to prevent the graft from slipping into the medullary canal when it is in place. If the graft

has been cut properly, it will sink slightly below the edges of the gutter when it is in place. Two holes are now drilled obliquely through each margin of the gutter in both fragments. The inlay is now fastened securely in place by passing kangaroo tendon through the drilled holes and tying over the graft, or by inserting an autogenous dowel peg in each drill hole. The wound is closed without drainage. The fractured extremity should be immobilized completely with plaster-of-Paris, or other suitable dressing. The period of immobilization should be at least twelve weeks.

UNUNITED FRACTURES

Local or constitutional causes. In considering the treatment of delayed union, or non-union, of fractures, it is important to determine whether the cause is constitutional or local. Although many general conditions have been attributed as the cause of failure of union, it is very probable that in most instances the fault is some local trouble. Constitutional disturbances, such as the presence of infectious diseases, pregnancy and lactation, prolonged illness, central nerve lesions, anemia or any exhausting condition, are of importance probably from their influence in depressing the general cellular activity. It is very likely that the interference with union in most cases is due to one of several local conditions, such as over-riding of the fragments, a separation of the fragments by the interposition of fascia, muscle or cicatricial tissue, or to disturbances of the blood or nerve supply.

In nearly all of our cases we have found that the ends of the fragments were separated by some soft tissue, and that this happens usually in patients who have sustained a violent injury so that the ends of the bones have been forced past each other with great power.

Bone is a special tissue and there will be no callous formation unless one fragment actually comes in contact with the other in some manner. Therefore, in order to secure union in any fracture it is essential that the bony tissue of one fragment actually comes in contact with the bony tissue of the other fractured end.

Union can be secured in the majority of cases by simply cutting down upon the fragments, removing all soft tissue between the fractured surfaces, freshening the ends and securing accurate apposition by fastening the pieces of bone together by the application of two heavy steel plates held in place by screws. In cases of non-union one should be especially careful to see that the bone is well plated.

The operation of choice, however, is the use of an intra-medullary splint of bone, as advised by Murphy, or the bone inlay method of Albee, as previously described. The latter method is especially indicated when one meets with a case of non-union in which the fragments are in accurate apposition but the ends of the bone are smooth and extremely hard, with no attempt whatever at osteogenesis taking place. This piece of bone gives a scaffolding through which the Haversian vessels travel through the Haversian canals of the transplanted bone. The transplanted bone is eventually absorbed and replaced by new bone.

Clinical history of a case in point. Patient forty-five years of age, a machinist by trade. Family history very good. Personal history good, in fact patient had never been sick until time of accident, several years ago, when he was kicked by a horse on the right arm, which produced a compound, comminuted fracture of the humerus at junction of lower and middle third. Wound became infected and patient remained in the hospital for a period of twenty-two months, during which time he underwent four surgical operations, some pieces of bone being removed each time.

At the time of leaving hospital, wound was completely healed, but there was no union of the two fragments of the humerus. One year later patient was operated upon for the

non-union. The ends of the bone were freshened and fastened together by means of silver wire. Again the bone did not unite and the wire had to be removed a few months later because of irritation. Two years later a second operation was performed, the ends of the fragments freshened and again fastened with silver wire, the result being the same as before. Two more attempts were made in like manner to secure union, but the result was the same each time. Later he received a bullet wound in left thigh. The bullet was not removed and has never caused any trouble. During past two years patient troubled some with belching of gas and some distress in epigastrium after eating, otherwise well until up to the present time. Patient comes complaining of a false joint in right arm at a point about three inches above the elbow.

Examination. Patient is well nourished, tongue coated, appetite good, bowels regular, chest is negative, abdomen negative.

Arm. Distance from right acromion process to olecranon process is 13½ inches. Distance from left acromion process to left olecranon process is 17 inches. Considerable atrophy of muscles of right arm, but muscles of right forearm are about normal. Patient has good use of forearm, the false joint in the humerus acting as the elbow-joint. The false joint in the humerus is ten inches distant from the right acromion process. The lower fragment of the humerus which was about 3½ inches long remained at right angles to the bones of the forearm. By grasping this fragment firmly and moving the forearm it was found that there was about twenty degrees motion in the elbow-joint. When the forearm was extended the lower fragment assumed a transverse position to the long axis of the humerus as shown in the plate.

Technique. Patient was anesthetized and an incision made on the outer surface of right arm on the false joint. The musculo-spiral nerve was exposed early in the dissection. It was markedly enlarged and imbedded in connective tissue in the region of the false joint. The nerve was dissected free and retracted. All of the connective tissue was dissected away, the ends of the bone were freshened by sawing off the rounded ends, and two fragments approximated and held in apposition by screwing two steel plates on the humerus. This was accomplished with considerable difficulty on account of the shortness of the lower fragment and the limited motion in the elbow-joint. It was necessary to place the forearm at right angles to the arm in order to bring the fragments in juxtaposition, making it rather difficult to apply the plates to the short lower fragment. After the plates were applied, the wound was closed and a cast applied with forearm at right angles to arm.

Cast was removed at end of twelve weeks at which time the bone seemed to be very firm. The arm was left without a cast and was examined again in a week. At this time union seemed very firm, there was absolutely no pain or tenderness and there was about thirty degrees of motion in the elbow-joint. A report two years later stated there was union of bone with no trouble from plates.

MALUNITED FRACTURES

In badly united fractures in which there is considerable loss of function, operation is indicated. This class of cases is often difficult to handle, especially if more than one bone is involved and if considerable time has elapsed since the injury. In every case an attempt should be made to correct the shortening as well as the alignment, and this can be accomplished completely, or nearly so, in every instance. In case of a femur in which there is an overlapping of from one to three inches, it is impossible by direct pulling to stretch the muscles sufficiently to allow the ends of the bone to come in apposition. This, however, can be accomplished very easily by bending the thigh upon itself so that the two ends of the bone are at right angles to each other, then grasp each fragment with a pair of heavy forceps and hold the ends of the bone against each other while some one straightens the thigh. This gives a tremendous leverage and the muscles are stretched without any difficulty. If there has been no recent infection to form connective tissue about the vessels and nerves,

there will be no danger of tearing the muscles, vessels or nerves, as normally they will stretch any reasonable distance.

In each case of fracture before open operation is attempted a careful history should be taken and a search made to determine whether or not there exists any constitutional disturbance, such as syphilis, anemia, hypothyroidism or other conditions that might possibly interfere with bony union.

Patients suffering from such disorders are poor surgical risks and should be subject to appropriate treatment to correct these diseases before operation is performed.

COMPOUND FRACTURES

In compound fractures the most important point to be considered is the production of conditions as nearly as possible like those in simple fractures. These conditions may be secured most readily by laying the wound open sufficiently to remove the extraneous matter which may have been forced into it at the time of the injury, or by the manipulations which occurred before the patient reached the hands of the surgeon. After the wound has been carefully disinfected by applying strong tincture of iodine, without using any soap and water, and all of the entirely loose fragments removed, those which have some attachment to the periosteum being carefully adjusted, the fragments should be placed in as nearly a normal position as possible, and if it seems likely that this position can be maintained by the use of external splints, then it seems proper that such external splints be applied. If, however, it is clear that this position of the fragments cannot be maintained then the same may be sutured in place by means of catgut sutures.

We seldom if ever introduce a Lane plate in compound fracture, because of the possibility of a septic infection following the introduction of a foreign body in these cases is so great that we prefer taking the chances of having the fragments unite in a bad position than taking the risk of placing screws or wire in a septic wound. After a compound fracture has healed, if there is much deformity, this can be corrected by an open operation. If in any given case of compound fracture it seems wise to introduce plates in order to bring the fragments in contact with each other, it is well to pack the wound wide open and then remove the plate as soon as union has taken place.

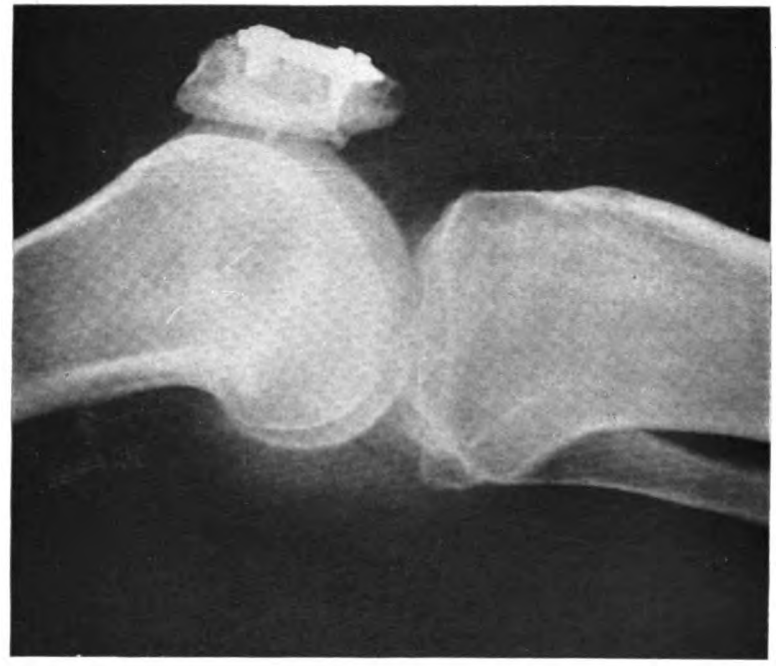
FRACTURES IN CHILDREN

Fractures in children seldom require open operation. In most cases the reduction of the fragments can be accomplished without much difficulty. Even though one cannot secure the parts in accurate apposition, union usually takes place rapidly, and any deformity that follows generally undergoes a modelling process and has a tendency to disappear.

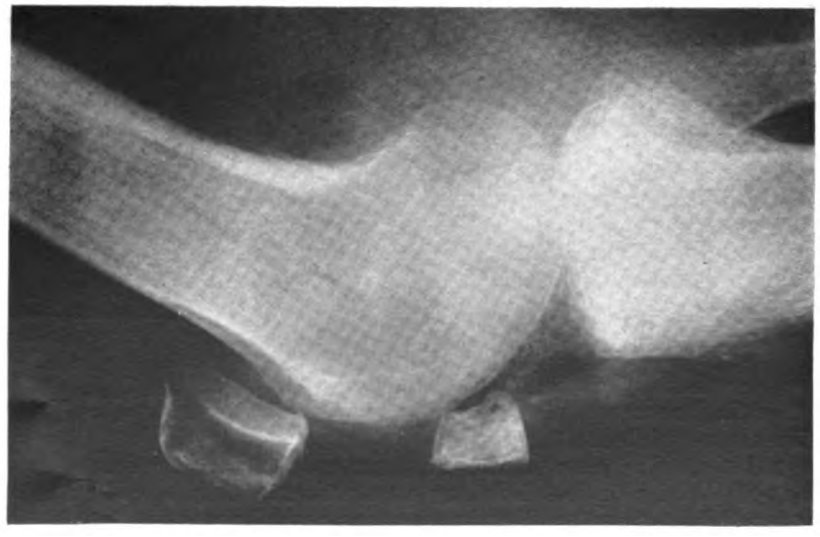
FRACTURE OF THE PATELLA

If the surgeon thoroughly controls the situation so that he can be certain of asepsis, then in fracture of the patella we believe the operative method is always indicated, as with it the patient may be out of bed in less than one week, he may walk about comfortably in three weeks, and in from eight to ten weeks he should be able to follow any occupation he may have had at the time of injury, while without such operative treatment he will be disabled for many months at best.

An illustrative case. A man, forty years of age, fell upon his right patella and fractured it. He had it treated by means of splints and strapping, and obtained a very satisfactory



B. Same case three and one-half years after plates were applied.



A. Ununited fracture of the patella. Five months' duration.

C.

Another view of the same case with plates in place three and one-half years.

result, which enabled him, at the end of six months, to pursue his occupation of book-keeper in a large establishment; the knee, however, never became thoroughly strong, and the patient could not take long walks without becoming exhausted. Two years later he fell upon the other knee and fratured the patella in the same manner. An open operation was at once performed and the extremity placed in a plaster-of-Paris cast. At the end of one week the patient was allowed to be out of bed. At the end of three weeks he was able to resume work in the office, continuing, however, to wear a cast. At the end of eight weeks his left leg was in a much better condition than his right, which had been injured two and one-half years before.

We have had numerous opportunities of making similar comparisons in fractures of the patella taking place in different persons at the same time, and are convinced that with a clean operator an open method is as safe as the treatment with splints, and has all the other advantages just mentioned.

Technique. A transverse, curved incision is made with its center three centimeters below the point of the fracture of the patella. This flap is turned up; the blood clots found to be present are sponged away with moist aseptic gauze pads; the two fragments are then placed in accurate apposition; and the capsule to each side of the fracture is sutured by means of chromicized catgut, which will last about two weeks. A few superficial sutures are then applied to hold the patella in accurate apposition, and the skin sutured over all. A small plaster-of-Paris cast is then applied and the patient placed in bed, with the extremity elevated. It is important that the extremity should be elevated, because this relaxes the quadriceps femoris muscle and consequently prevents pulling upon the upper fragment.

After six or eight days the patient is permitted to sit up out of bed, and after three weeks he is allowed to walk, with a cast upon the extremity. Five or six weeks after the operation the cast is removed and the patient permitted to walk with a cane. It is neither necessary nor desirable that the patient should walk with a crutch at any time. In case there should be a certain amount of limitation of motion in the knee after recovering from this operation, which, in our experience, has been very rare, this can be overcome most readily by having the patient ride a bicycle, or a tricycle if he is not accustomed to the former.

The result is so much better after this treatment than after the methods ordinarily in vogue that we believe it should become a recognized method, only, however, in the hands of clean surgeons.

FRACTURE OF THE OLECRANON

The recovery from a fracture of the olecranon is ordinarily so much easier, and the conditions after healing are so perfect if the fragments are united by the use of catgut sutures, that here also an operation is indicated.

Technique. A longitudinal incision is made directly over the middle line of the olecranon process and the soft tissues are carefully retracted in order to avoid injuring the ulnar nerve. It is important at this point for the surgeon to bear in mind the relative position of the olecranon and the ulnar nerve, as, if the operation is performed with the hand in the position of pronation the surgeon may be confused by the fact that ordinarily we carry the relations in our mind with the hand in the position of supination. The nerve mentioned passes between the internal condyle and the olecranon, but when the hand is pronated so as to place the olecranon in a convenient position for operation, then the internal condyle is turned to the outer side. If this fact is borne in mind the nerve may be very easily avoided. Here, again, the fragments of bone are united by means of chromicized catgut, which will last about fifteen days. In case a sufficiently firm hold can be obtained by passing these sutures through the periosteum and the surround-

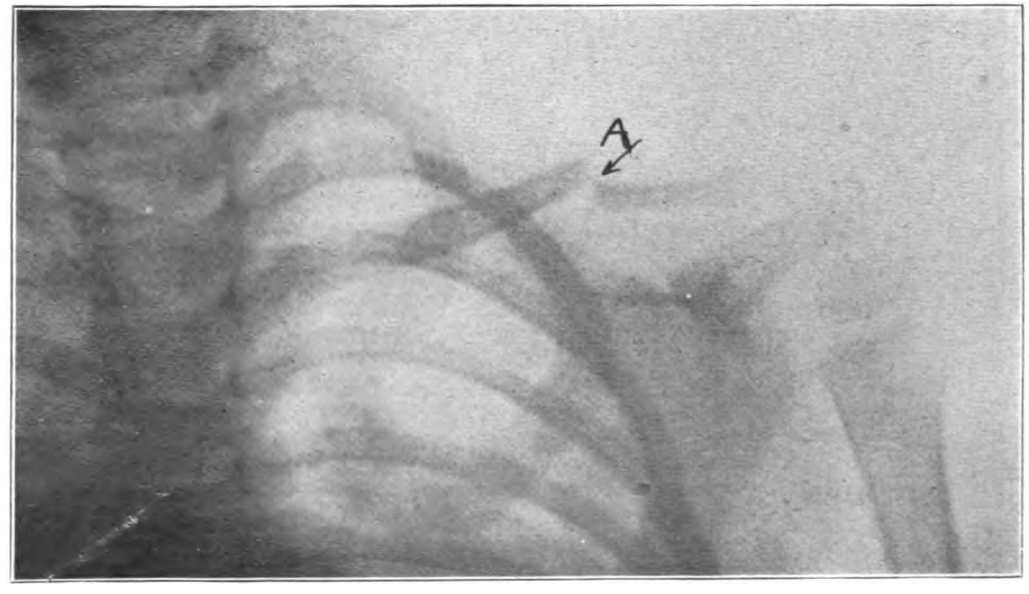
ing soft tissues to retain the fragments in perfect juxtaposition that is all that will be required. If this cannot be done a small opening should be drilled through the middle of the olecranon process and through the upper end of the ulna, and a suture passed through this. The arm should be dressed in the extended position by means of a plaster-of-Paris cast.

FRACTURE OF THE ACROMION PROCESS

In fracture of the acromion process, in which it is found difficult to maintain the proper position, an incision should be made parallel with the spine of the scapula, the fracture should be exposed with as little disturbance of the soft tissues as possible, and the fractured end sutured in place, if possible, by passing the sutures through the soft tissues. If it is not possible to firmly adjust the fragments in this manner small openings should be drilled into the end of each fragment and at least two chromicized catgut sutures applied in order to secure a perfect coaptation.

FRACTURES OF THE OUTER END OF THE CLAVICLE

In very rare instances a fracture occurs near the outer extremity of the clavicle which cannot be retained in any reasonable position by means of dressings ordinarily used for this purpose. In such event the most superficial



FRACTURE OF THE OUTER THIRD OF CLAVICLE.

portion of the bone should be sought, namely, upon the line between the attachment of the trapezius muscle and the deltoid, and an incision at this point should expose the fracture, which can then be readily adjusted by means of a few catgut sutures. After these have been applied the skin is sutured and a rubber adhesive plaster applied upward from the chest, covering both fragments and extending backward over the scapula. The arm is then placed in a sling and carried in this position for a period of three to six weeks.

In these cases we now frequently use the Lane plates because they hold the ends in absolute coaptation and produce ideal results.

In the same region occasionally a severe traumatism causes a dislocation of the outer end of the clavicle, loosening its attachment to the acromion process of the scapula, the acromio-clavicular ligaments being completely lacerated. Ordinarily this dislocation can be reduced by means of properly applied rubber adhesive straps, but if such a result is found impossible then the incision which has just been described for the treatment of a fracture at the outer end of the clavicle should be made, the dislocation reduced, and the ruptured acromio-clavicular ligaments carefully sutured with chromicized catgut. The dressing just described in connection with the rubber adhesive plaster dressing should be applied and a second broad strap of rubber adhesive plaster adjusted as follows: Beginning about the angle of the eighth or tenth rib the plaster is passed upwards and outwards, so that its middle portion strikes the end of the clavicle. It is then carried forwards and downwards and passed around the forearm four centimeters below the end of the olecranon process with the arm in the flexed position. In this manner the leverage of the arm upon the adhesive plaster straps serves to hold down the end of the clavicle in position and relieves the tension upon the chromicized catgut sutures.

EPIPHYSEAL FRACTURES

In epiphyseal fractures in any portion of the skeleton in which, after careful manipulation under anesthesia, it is found impossible to adjust the fragments, it is desirable to resort to an open operation at once—always providing that the surgeon completely controls the conditions of asepsis. The deformities which occur after these fractures are unusually annoying, because of their proximity to the joints. This fact, of course, makes the open operation more hazardous, but the benefits of the operation are so great in cases in which, after careful trial, it has been found impossible to adjust the fragments, that the surgeon is justified in taking the additional risk. Where the fractures have not been adjusted there will be found a retardation of growth from the epiphyseal line involved, aside from the deformity. Whether this can always be avoided by an open operation it is impossible to say with the relatively small amount of clinical observation upon this subject, but in cases in which the operation has been done the results have been much more satisfactory than in those in which the irreducible deformity has been permitted to persist.

In the majority of cases of epiphyseal fractures, the fragments can be retained in good position after they have been replaced by open operation, without the introduction of any foreign body, such as nails, screws, wire or plates. If in any given case it becomes necessary to introduce a nail or screw across the epiphyseal line it should be removed as soon as union has taken place, so as not to interfere with the growing line.

NON-UNION OF THE NECK OF THE FEMUR

In all cases of non-union of the neck of the femur, and in a few cases of primary fracture of the neck of the femur, in which it does not seem likely that a good result can be obtained by non-operative treatment, the use of a large bone peg is the operation of choice. The fragments are exposed in the usual manner, and the ends of the fragments freshened by a sharp curette or chisel, and all redundant soft tissue removed, so that it cannot possibly slide in between the fragments. The fragments are now brought in as near normal to position as possible, and fixed temporarily by passing two Lane bone drills up through the shaft and neck into the head of the femur. A bone graft about one-half inch in width is now cut from the tibia and is driven up through the

shaft and neck into the head of the femur, which makes a firm fixation of the fragments. The wound is closed in the usual manner, and hip immobilized with a plaster-of-Paris cast for a period of fourteen weeks.

For a number of years the authors used long wood screws as a means of fixation, with satisfactory results in every case. This method has the advantage over the various forms of nails in that one can draw the fragments in closer apposition and the screw does not loosen as easily as nails.

After the fragments have been freshened by a sharp curette or chisel and brought into apposition, a steel screw about three inches in length is selected and a hole somewhat smaller than the screw is drilled through the femur at a point about one inch below the great trochanter, passing through the neck into the head of the bone. The screw is placed and turned in until the two fragments are drawn into close union. A tenpenny nail is then driven in at a point about half to three-quarters of an inch distant from the screw and at a slightly different angle. This prevents rotation of the head upon the shaft.

CONGENITAL DISLOCATION OF HIP

Causation. Congenital dislocation of one or both hips is quite a common condition, but frequently the true condition is not recognized until the child has reached an age when the treatment is very difficult. There is little known about the etiology of this condition, although several causes have been suggested by various authors, viz., injury to the mother during pregnancy; an abnormally small amount of liquor amnii; injury at time of birth and retardation of growth of the acetabulum. The correctness of these opinions has never been proven or disproven, nor has any one been able to explain why the condition happens about seven times as often in girls as in boys.

Pathology. Most observers seem to agree that when present the acetabulum is always in the right place, and some state that however rudimentary the acetabulum may be, it is always present. The acetabulum is usually very shallow, because in the first place it has not developed fully, and, secondly, it is more or less filled with cartilaginous, fibrous or fatty substance. The head of the femur is usually normal, or nearly so, in size, so consequently it is always disproportionately large. The ligamentum teres may be absent or drawn out into a long, thin band. The capsule is greatly elongated and often has an hour-glass constriction at its middle. In double dislocation the pelvis hangs on the femora by the drawn-out capsule, instead of resting upon and being directly supported by the heads of the femora. The pelvi-femoral and pelvi-crural muscles are shortened.

Signs and symptoms. The signs and symptoms differ somewhat according to whether the dislocation is single or double. For convenience we have divided them into three groups.

Group 1 comprises those common to both forms of dislocation; Group 2, those which are found only in double dislocations; and Group 3, those which are found only in single dislocations.

Group 1. Prominence of the buttocks. This is sometimes very marked, having the appearance of a lipomatous tumor. The upper border of the great trochanter projects well above Nélaton's line. The head can be felt on the posterior surface of the acetabulum, and there is a depression instead of a prominence in the groin just external to the femoral vessels. If the pelvis is grasped firmly and traction made on the thigh, the head can be felt to move downward without imparting the motion to the pelvis, i.e., undue passive motion at the hip, though active motion is usually about normal. The patients learn to walk late, fall easily at first, are easily fatigued, and when they become

very tired often experience a dull, aching pain at the hip and knee. A good skiagraph always shows the dislocation.

Group 2. Waddling, duck-like gait; more or less marked lordosis; prominence of the abdomen; squat figure. This last can be determined by careful measurements. It can always be demonstrated that there is a disproportion between the distance from the anterior superior spines of the ilii to the internal malleoli and the height of the body.

Group 3. Marked limp; pronounced scoliosis; shortening of the affected limb as determined by measuring from the anterior superior spine to internal malleolus.

Diagnosis. If in each individual case of deformity of the hip or back we will but remember the possibility of its being a congenital dislocation of the hip, and recall the above enumerated signs and symptoms, the diagnosis is usually easy, as in each case all, or nearly all, of them can be found. In the past a goodly number of these cases have been diagnosed as coxitis, simple spinal curvature, infantile paralysis, rickets, or Pott's disease. In every patient where this condition is suspected, an X-ray picture should be taken, and if present the head of the femur will be shown to be a considerable distance above the acetabulum, making the diagnosis positive.

Treatment. During the past sixteen years the authors have used the "bloodless functional weight method" of Lorenz with excellent results in the majority of cases.

Reduction is accomplished in the following manner: It is necessary, first, that a general anesthetic be used to secure a state of complete relaxation. Then while one or two assistants hold the pelvis of the patient, the operator grasps the thigh just above the knee and makes a steady downward pull, rotating the thigh back and forth somewhat while the traction is made. As soon as the upper border of the trochanter is well down to Nélaton's line, the first step has been accomplished. It is next necessary to bring the thigh into a position of complete abduction, which is so essential in making the head slip over the posterior rim of the acetabulum. This is accomplished by steady, moulding manipulations. Sudden jerks should be avoided because while securing abduction one is liable to fracture the neck of the femur. If abduction to a right angle cannot be accomplished, subcutaneous tenotomy of the adductors must be resorted to.

As soon as the required degree of abduction has once been accomplished, the pelvis is steadied by an assistant, the thigh is flexed to a right angle and slightly rotated inwardly. While one hand of the operator presses on the trochanter, the other hand makes strong, steady traction forward, and at the same time attempts slow abduction. The head slowly creeps up over the posterior border of the acetabulum, and suddenly slips over the rim, bounds into the acetabulum with a distinct thud, which sometimes can be heard at a considerable distance, and with a vibration of the patient's body, which is always transmitted to the operator, and sometimes even to the table and to those who may be in contact with it.

The other signs of an accomplished reposition are: Distinct lengthening of the thigh; the development of a fullness in the groin and the disappearance of the head of the femur on the posterior surface of the ilium; and the sudden tenseness of the hamstring tendons characterized by inability to extend the knee. The object of the inward rotation is to loosen the capsule from the rim of the acetabulum and to utilize the head of the femur as a wedge to open up any hour-glass constriction in the capsule. Reposition having been accomplished, we must now make every effort that this be rendered stable. This is secured, first by a boring motion. The thigh is rotated outward, and with a boring motion the anterior capsule is stretched and the

acetabulum deepened; second, the tense pelvi-femoral and pelvi-crural muscles will help to deepen and enlarge the acetabulum; and, finally, third, the weight of the body in walking will greatly aid the formation of a satisfactory joint in removing the deposits in the acetabulum and securing the development of a broad cotyloid ligament. In order to fully utilize this important principle a cast must be applied with the thigh in complete abduction and at right angles to the acetabulum in all directions. The cast should be applied over two thicknesses of stockinette and include the entire thigh and pelvis as high as the umbilicus. This degree of abduction does away with any tendency of the head to slip out of the rudimentary acetabulum. The child is allowed to walk as soon as it wishes.

In single dislocations a high sole is placed under the shoe of the operated leg so as to make walking a little more comfortable. In double cases a stool can be made on which the child may sit astride and still bear the weight on the feet.

The first cast is worn four months, when it is removed, and the thigh brough down to an angle of forty-five degrees of abduction and slight flexion, and another cast applied in this position. This cast is worn about eight to ten months, when the child can usually go without any appliances. While wearing the casts the child should be encouraged to walk a great deal, as that will help to deepen and develop the acetabulum and to strengthen the muscles of the thigh and the structures of the joint.

Prognosis. If one succeeds in replacing the head in the acetabulum the chances of a complete and permanent recovery are very good. In cases of single dislocation in patients six years of age or younger, and in double cases five years of age or younger, reduction of the dislocation can usually be accomplished by the Lorenz method. Occasionally reduction can be made in patients quite a little older than the ages given above. The most favorable time for treatment, however, is when the patient is between three and one-half and four years old.

BONE TRANSPLANTATION

Osteogenesis. The operation of bone transplantation has become a thoroughly established surgical procedure, but there still exists considerable controversy as to the manner of regeneration of bone or upon what it depends. Among the various views upon this point are those of Axhousen, who maintains that the bone in the graft always dies, and that it possesses power of regeneration by virtue of its periosteum. On the other hand, Macewen claims that the bone in a graft is reproduced from the osteoblasts within the bone of the graft itself and that the periosteum simply acts as a limiting membrane to keep the osteoblasts from spreading into the surrounding tissues. Another view is that of Murphy, who contends that the graft is not osteogenetic, but simply osteo-conductive. That a bone graft when placed in contact with other living bone acts simply as a mechanical support for the Haversian blood vessels and the living osteogenetic cells as they advance from the living bones at both ends and pass through the Haversian canals, canaliculi and lacunæ of the transplant.

Phemister, after a long series of experiments, came to the conclusion that osteogenesis in bone repair occurs from the inner layer of the periosteum, from the endosteum and to a much less extent from the bone cells and fibrous contents of the Haversian canals. The viability of the cells of the transplant is dependent largely upon their ability to get nutrition. Periosteum and endosteum being located superficially receive sufficient nourishment to survive and proliferate. The great mass of bone cells being away from the sur-

face and surrounded by an extensive, calcified matrix gradually undergo necrosis and absorption. McWilliams, after a series of experiments, states that "The life of a living graft depends entirely on its receiving sufficient blood to keep it alive and nothing else. The presence of periosteum on a graft has a favorable influence on the nutrition of the graft, that is, increases the blood supply to its cells, so as to keep it alive, or in case the bone cells in the graft die from insufficient nourishment, the periosteum supplies living cells to the graft, by means of which the bone is regenerated."

After carefully considering all of the various experiments it seems as if the conclusions of Phemister and McWilliams are probably correct, that is, that in bone transplantation the regeneration takes place from the inner layer of the periosteum, the endosteum and somewhat from the bone cells and fibrous contents of the Haversian canals, and that the life of the graft depends entirely on its receiving sufficient blood supply to keep it alive.

The practical conclusion to be drawn from all of the various experiments on bone transplantation is, that in order to be assured of the subsequent vitality of a bone graft, as much of the periosteum as can be obtained should accompany the graft.

Indications for bone transplantation. 1. For the repair of recent or ununited fractures.

2. To replace bone which has been destroyed by infection, such as osteomyelitis, tuberculosis, etc.

3. To replace bone that has been removed because of having been the seat of a non-malignant neoplasm, such as cysts and osteitis fibrosa cystica.

4. To replace bone that has been removed in cases of encapsulated malignant disease, such as giant-celled sarcoma.

5. To produce a bony ankylosis of the vertebræ, in cases of Pott's disease of the spine, as devised by Albee, and also to produce an ankylosis of the spine in cases of fracture of the vertebræ.

6. To correct bony deformities, either congenital or acquired, such as saddle-nose.

Important features of the bone grafting operation. 1. It is absolutely necessary that the strictest asepsis be maintained throughout the entire operation, as primary union is essential to insure good results. The field of operation should be aseptic, that is, a graft should not be placed in an area that is not primarily aseptic.

2. The transplant should be placed in contact with living bone, at least at one end, and preferably at both ends.

3. The graft should be taken from the patient himself. The crest of the tibia is a very suitable area from which to remove the transplant, as it is easily accessible, and a graft of most any length can be obtained. Taking a graft from this region does not incapacitate the patient at all, as it does not interfere with the weight-bearing power of the tibia.

4. The transplant should be large enough to give a firm, immediate mechanical support. Its length should be considerably more than the gap it is to fill, so that it can be securely fastened at both ends, giving it as much contact with living bone as is possible.

5. To insure success the transplant should be covered with periosteum.

6. In removing the graft, which can readily be done either with a carpenter's chisel or one of the various electrical saws, care should be used to preserve the integrity of the graft.

7. The extremity in which the graft has been placed should be supported by some form of external splint for a period of eight to twelve weeks, as it takes this length of time for the graft to become firmly attached. After the external support has been removed, the patient should be very cautious in

the use of the extremity for another six months, as it requires from six to twelve months for a bone to become restored to its normal size.

OSTEOMYELITIS

Patients suffering from acute osteomyelitis usually give a history of a sudden attack of pain, most frequently at the point of entrance of the nutrient artery or near one of the epiphyseal extremities of one of the long bones. This attack usually occurs after exposure to wet and cold.

In many cases it is possible to trace a history of follicular tonsillitis as the source of the infection. The pain is extreme upon pressure and most extreme early in the disease at one particular circumscribed point. The patient has high fever and feels thoroughly ill, having the general appearance of one suffering from acute sepsis. The pain becomes more and more diffuse and the extremity becomes swollen and later on edematous and reddened, and ultimately fluctuation will appear. In a very large proportion of these cases the early diagnosis is that of localized rheumatism, and, *vice versa,* conditions giving rise to a diagnosis of localized rheumatism near the center of a long bone, or near one of the epiphyseal lines, practically always means that the patient is suffering from acute osteomyelitis. In many the disease seems to have been located by a slight traumatism. Of course, it is always necessary to bear in mind that the osteomyelitis may have existed and that the traumatism was but a coincidence.

Operative technique. It is necessary only to bear in mind the pathological conditions present in order to determine the proper treatment. There is a violent circumscribed infection which, if left undisturbed, is certain to progress along the blood vessels and lymph channels and become more and more diffuse. The bone is surrounded by a tense membrane, the periosteum, and consequently the products of the infection cannot easily escape, and the pressure caused by these against the sensitive periosteum gives rise to the excruciating pain. It is plain, then, that in order to secure relief from pain conditions must be established providing for the escape of the products of infection confined within the periosteum. This may be accomplished most readily by making a long incision through all of the tissues down through the periosteum. Such treatment at once permits the septic material to escape, it relieves the pressure, stops the pain, and directs the lymph stream away from the body and therefore prevents the progress of the infection.

A number of years ago many excellent surgeons at once removed the infected bone. In some instances the entire shaft of one of the long bones was found diseased and entirely removed, and it seemed as though this was the only logical way of treating so intense an infection. However, experience has taught that in these cases in which large portions of bone in acute osteomyelitis were removed there was no reproduction of new bone to take the place of that removed, and consequently the extremity was left without bony support. On the other hand, it was found that if the periosteum was simply split open the recovery was exceedingly rapid from the acute attack, and many times a bone which seemed entirely lost regained its vitality and continued to perform its physiological functions, while in other instances a bone which seemed entirely destroyed regained its vitality to a great extent and it was later necessary to remove only a small portion of necrotic osseous tissue. Again, experience has taught that so long as the diseased bone was left in place there was rapidly produced between this portion and the periosteum a layer of new bone, known as the involucrum, which in a few months became strong enough to substitute the diseased bone after this was removed, and in such cases the reproduction of bone after the removal of the necrotic bone tissue progressed to such an

extent that almost the entire structure was reformed. Moreover, those who have frequently operated upon osteomyelitic bone have found that even without the aid of drainage, resulting from the incision just described, almost all of these patients suffering from acute osteomyelitis recover and become chronic and that then it is possible to remove the diseased bone and still leave a perfectly useful support for the extremity in the form of the new involucrum.

In all cases of acute osteomyelitis, then, the primary operation should consist in an incision extending some distance beyond each end of the infection in the bone and must penetrate all the tissues down to the bone, including the periosteum. The drainage can be still further improved by the application of large, moist antiseptic dressings to the extremity and, of course, complete rest. A saturated solution of boric acid, or of acetate of aluminum, or a thirty per cent. solution of alcohol in hot water, are most useful fluids for this purpose. The entire extremity should be enveloped in this dressing and covered with an impervious substance like oiled silk or gutta percha tissue, or an ordinary rubber cloth. Fresh solutions should be added three to six times a day. The dressing itself need not be removed more than once every two to four days. The pain subsides almost instantly, and within a few weeks the incision usually heals, with the exception of a circumscribed point in case the bone does not entirely recuperate.

Only rarely does the surgeon see a case of osteomyelitis at the very beginning of the attack, when the infection is still confined to a limited area one or two centimeters in diameter, which can be located because of the extreme tenderness in a particular point. In these rare cases the bone should be opened with a very sharp chisel. The infected tissue should be gouged and scraped out with great care and the cavity filled with ninety-five per cent. carbolic acid for five to ten minutes, and then thoroughly washed with strong alcohol. The skin may be sutured over this directly or the cavity tamponed for a few days and then sutured secondarily. Too much stress cannot be laid upon the importance of immediate early operation because this will save the patient an endless amount of time and suffering. No palliative treatment should ever be used.

In the event of a circumscribed portion of bone becoming necrotic it should be left in place until it has been thoroughly covered by an involucrum, developed between the necrotic bone and the periosteum. After this has become sufficiently strong to support the extremity it should be treated after the method to be described in connection with chronic osteomyelitis here following.

CHRONIC OSTEOMYELITIS

Patients suffering from this disease most commonly give a history of acute osteomyelitis, which may have been treated after the method just described, or, more frequently, have been diagnosed as acute localized rheumatism and treated accordingly. Often the condition has progressed to the formation of an abscess, which may have ruptured spontaneously or been laid open by the surgeon. The sinus resulting from this abscess refuses to heal entirely, or it may heal and open from time to time, the patient feeling comparatively comfortable whenever the sinus is open and suffering from pain when it is closed.

The infection may be due to one or more of the pus microbes, to the typhoid bacillus, the pneumococcus or to the bacillus of tuberculosis. If the latter form of infection exists alone the onset and the progress of the disease is usually slower than if due to any of the other micro-organisms mentioned.

The condition must be differentiated from syphilitic osteitis or periostitis. The latter is preceded by a history of syphilis or of hereditary syphilis, or there may have been syphilitic infection without any obtainable history. The progress of this condition is, however, slow; it is characterized by less acute, or rather more deep-seated, pain, which is likely to be more severe at night than during the day-time. The characteristic mark of this disease, however.

is the spindle-shaped appearance of the diseased bone and the tendency to elongation and bending of the bone, in case the long bones are involved, which is not very common except in the tibia and occasionally the femur. Syphilis more commonly attacks the flat bones; tuberculosis the joints, the epiphyses and the short bones; while osteomyelitis most commonly involves the long bones.

The diagnosis of syphilitic osteitis or periostitis may be eliminated by the administration of salvarsan, by the vigorous use of mercury, and by large doses of iodide of potash continued for a period of from two to six weeks. If no distinct improvement occurs the condition is probably not due to syphilis. Very rarely is there any difficulty in making a differential diagnosis between osteomyelitis and sarcoma, because in the latter there is the distinct formation of a tumor. Well made X-ray plates are of the greatest diagnostic importance in chronic osteomyelitis, because they enable the surgeon to determine the exact size, form and location of sequestra. On the other hand, it is a fatal error to employ X-ray in the diagnosis of acute osteomyelitis, because it cannot show the pathologic condition until it is too late to save the bone from serious harm by an early operation. In case X-ray examination is employed in cases in which early osteomyelitis has been diagnosed from the history and physical examination. A free incision should invariably be made through all the tissues including the periosteum even in cases in which the X-ray plates are entirely negative.

Operative technique. The treatment of chronic osteomyelitis consists in laying bare the diseased bone, reflecting the periosteum, chiseling away a sufficient amount of the involucrum to permit of the removal of the necrotic bone; then the involucrum should be chiseled away in each direction sufficiently to permit of the complete removal of all infected tissue. The granulations should be curetted away until the surface of bone is perfectly smooth and free from any of these structures. During the chiseling operation it is frequently necessary to employ great care to prevent the production of a fracture, as if the entire shaft of the bone has been necrotic the involucrum is frequently not strong enough to bear any severe strain.

In planning an operation for chronic osteomyelitis one should, if possible, arrange to leave the conditions so that a sufficient amount of the involucrum may safely be chiseled away to leave the space caused by the removal of the sequestrum entirely on one side of the bone, so that there will remain no cavity which cannot be filled by the falling in of the surrounding soft tissues. If, however, the conditions present will not permit this, the ledge of bone on one side or the other of the groove formed after the removal of the sequestrum should be chiseled parallel to the bone, remaining attached, however, to its periosteum, so that the entire ledge may be folded in against the remaining portion of the bone which is continuous above and below with the healthy structure. This prevents the formation of a cavity with unyielding walls and will facilitate healing after the operation for chronic osteomyelitis very greatly. After all of the diseased tissue has been removed the surfaces of the bone may be swabbed with ninety-five per cent. carbolic acid, which may be left in contact for from two to five minutes, and then the cavity should be thoroughly washed with strong alcohol to remove the superfluous carbolic acid.

It has been our custom to apply strong compound tincture of iodine to these surfaces after the alcohol has been sponged away and then close the wound with sutures and apply a large antiseptic dressing, and to support the extremity by means of a splint. If, however, there is doubt about the complete removal of all the infected tissue, it is much wiser to tampon the cavity with iodoform gauze, and, if found aseptic after a few days, to close the wound by secondary sutures.

In cases operated repeatedly without permanent success, it is especially

desirable to obliterate the medullary canal completely in order to leave no space to become the seat of a new infection, or that may contain a focus of old infection. This can be best accomplished by chiseling away the entire portion of bone forming the walls of the medullary canal, except on one side. It is not necessary to retain much bone, as repair will begin at once, and in a few weeks the bone will again have its normal size. It is, however, important to exercise care not to fracture the bone during the operation. The patient should be kept thoroughly under the influence of the anesthetic, as a sudden motion on his part may result in a fracture.

SEPTIC INFECTION OF THE EXTREMITIES

Typical case. The patient is forty-eight years of age, works in a lumber yard, and gives the following history: His family history is negative. He suffered from the ordinary diseases of childhood; four years ago he had pneumonia, but otherwise has always been well. Four days ago he noticed a slight swelling of his left thumb, which was ascribed to the fact that two weeks ago a small sliver of wood entered at the point of the swelling. At first he paid no attention to this, but last night he suddenly began to feel exceedingly ill. The swelling extended rapidly over the entire hand, and red lines indicate the course of the superficial lymph channels along the palmar surface of the arm to the axilla. There is a very small point at which the sliver entered the end of the thumb. All the infected portions are exceedingly tender.

The patient is a strong, well-nourished man. A physical examination shows his heart, lungs, kidneys and abdominal organs to be normal. His temperature at the present time is 102½° F., pulse 124, respiration 20. He has the appearance of being extremely ill. During the past night he was delirious, and his friends state that his fever was very high—although the temperature was not measured.

If this patient were permitted to sit up or walk about with some small local dressing applied to his thumb, we are certain that in a few days he would develop a palmar abscess, and judging from the extension of the swelling at the present time, this would later be followed by an abscess of the forearm, and still later the axillary glands would suppurate.

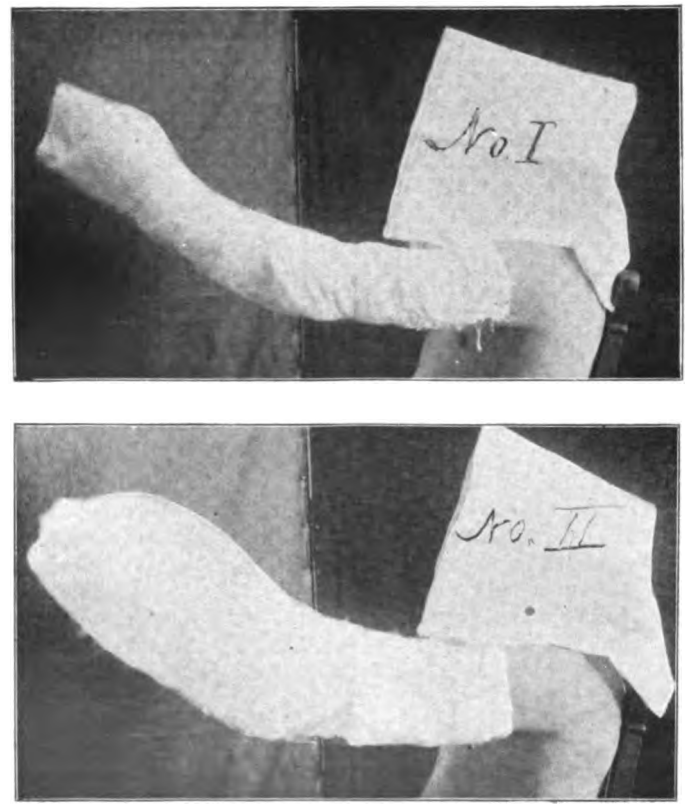
Every practical surgeon has made the following observation in these patients many times, and possibly also upon himself. A slight infection of the finger occurs from a prick with a needle or from some other slight injury. During the day the finger, and even the hand, becomes painful. The next morning the pain has entirely disappeared and the patient imagines himself well, but during the day the pain returns, perhaps a little more severe than the day before, and on the following night it again disappears, only to a less extent. After a few further repetitions a serious infection may become established, resulting in the destruction of a considerable amount of tissue, which will probably be followed by a marked impairment of the function of the extremity.

The explanation is very simple. During the day when the extremity is frequently moved the infectious material is carried from its circumscribed area to points farther up the arm. The following night this progress is again inhibited, because of the complete rest in the muscles of the arm, and there is a corresponding diminution in the symptoms. If the rest be continued the progress is permanently inhibited and the patient recovers completely. If this is not done it will ordinarily advance until he is so ill that rest is compulsory.

Treatment. Our treatment consists in carefully cutting away the thickened skin over the point of the thumb in order to permit any infectious material still existing at the original point of entrance to escape. The great danger to the patient, however, comes from the infection which has already extended beyond the original area, and we consequently apply to the entire arm the dressing shown herewith. The patient will also receive a cathartic, preferably two ounces of castor oil in the foam of beer or malt extract, in order to remove from his alimentary canal any products of decomposition which might depress his general system. As a result of this dressing, com-

bined with absolute rest, we will expect the temperature to be practically normal within two days, and the worst consequence that can happen lies in a circumscribed, harmless abscess that will heal within a few days after being laid open.

Even the severest infections of the extremities, such as may result from wounds received at post-mortems, pin pricks or slight abrasions, nail punctures, etc., will subside within a few days if the two very simple requirements indicated above are established. The more important of these is *rest.* The septic material is carried from the original point of infection through the lymph channels. It is, however, a fact which has been repeatedly demonstrated, that this progress is very slow if the extremity remains perfectly at rest, and much more rapid if the muscles of the arm are active, because their



LARGE, MOIST ANTISEPTIC DRESSING.

Each finger is first separately covered with gauze. Then the entire hand and arm to the shoulder are wound loosely with gauze, then with cotton, all being saturated with a mild antiseptic solution. The entire dressing is then covered with rubber cloth or some other impervious material. The patient should be in the recumbent position and the extremity elevated. The object of the picture is to show the extent and size of the dressing.

contractions virtually pump the micro-organisms onward in the lymph channels. If a patient suffering from an infection of the hand or finger is placed completely at rest the inflammation will remain nearly stationary, even if there be no further treatment, while as soon as the patient begins to use the extremity there is a marked exacerbation of the inflammation. This we have observed a great many times.

Antiseptic dressings. The next important point in the treatment consists in the application of large, moist, antiseptic dressings. It does not matter

whether the infection be slight or severe at first, one cannot feel certain that it will not increase in severity, and this increase in severity may be followed by very unfortunate results—such as palmar abscesses, necrosis of the tendon sheaths with the subsequent deformity and stiffness, or the axillary glands may become involved and be destroyed by suppuration, which may be followed by pyemia and death. This, however, will not be the case if the extremity is put absolutely at rest as soon as the diagnosis is made and a large, moist, antiseptic dressing is applied. The accompanying plate illustrates this dressing. It consists of five to ten yards of soft, antiseptic gauze, loosely rolled around each finger separately, then about the hand, wrist, forearm and arm to the shoulder. This is surrounded by a pound of absorbent cotton, and then by a rubber cloth, to confine the moisture and retain the temperature. Fresh antiseptic solution is poured into the dressing every one to six hours so as to keep the extremity constantly in contact with this fluid.

The dressing is renewed once in forty-eight hours and the entire extremity carefully inspected to locate circumscribed abscesses which may form, although the vast majority of these cases get perfectly well without the development of an abscess. Occasionally the circumstances may be such as to make it desirable to inspect the extremity after twenty-four hours, but usually it is better to leave the dressing undisturbed for a longer period. If an abscess has formed this is laid open, care being taken not to open into any of the surrounding healthy tissue, for that is likely to result in a progressive infection. Above all things these extremities should not be squeezed or manipulated during the dressing. We have frequently seen a patient's temperature rise several degrees, and the infection progress to a marked extent, after such manipulations. It is painful to observe a surgeon inflicting upon one of these patients what might be termed diagnostic massage, and forcing the septic material out of its fairly circumscribed and consequently relatively harmless position into the surrounding tissues.

Avoid manipulations. The slightest touch will suffice to indicate the presence of a circumscribed accumulation of pus, and still one frequently observes a physician *squeezing* and *crushing* these inflamed tissues for several minutes, to no purpose whatever apparently, while he is collecting his sluggish thoughts. It is well to remember that much harm may be done in this manner.

If there is a deep-seated abscess on the palmar side of the hand it may easily be located by gently pressing. There is, however, no doubt but that it is much better for the patient if these abscesses are opened a little too late than a little too early, as their contents become much less virulent from day to day and if the extremity is kept at rest there will be no progressive infection.

We have recently looked up the cases of severe infection of the fingers which we have treated in one hospital during the past few years, and find that of the entire number there was not one coming without an incision of the palm or forearm whose hand was disabled as a result of the infection or the treatment; while among those who had been treated with small dressings of any kind, without absolute rest and with the palms or forearms incised before entering the hospital, deformed and stiff hands were the rule.

We have made extensive observations with a large number of these cases and have found that the patients have progressed most favorably when the following antiseptic solution was poured into the dressing every one to six hours:

Boric acid, saturated solution in water.....six parts.
Carbolic acid, five per cent. solution.....one part.
Alcohol, ninety-five per cent.....one part.

It is astonishing how rapidly a most violent, progressing infection of the extremity will be changed into a perfectly stationary, harmless affection if the two conditions mentioned are thoroughly applied.

Typical case. A young, vigorous farmer, about thirty hours before entering the hospital, had produced a slight injury with a dirty file while repairing some portion of an old halter. During this short time the infection had made such violent progress that the patient seemed to be in a hopeless state. He was delirious, his entire arm to the shoulder was edematous and red, his hand was severely swollen, the fingers were gangrenous and this condition had progressed upwards rapidly. Under the treatment just described, the line of demarcation formed, there was no further progress in the infection and the edema subsided rapidly. Before entering the hospital a small dressing had been applied. Until the patient became delirious he was permitted to walk about the room, which he did in the hope of reducing his suffering. As usual, the pain subsided rapidly after the form of treatment before mentioned was employed, and there was no progress of the disease, although this had been constant and very rapid previously. We have chosen this case for illustration because of its great violence.

It is doubtful whether the antiseptic solution in the dressing has much influence upon the infection directly, or whether the benefit comes entirely from the effect of the rest and the moist heat. Professor Kahlenberg has demonstrated positively, that within a few minutes after the application of moist boric acid dressings to the skin the urine shows the presence of the antiseptic, consequently it seems reasonable to suppose that there is direct benefit from the use of this remedy.

Electric Light Bath Apparatus for an Extremity.

The use of electric light treatment to overcome pain and to control infection. In a personal experience with septic infection of the elbow directly over the area at which the ulnar nerve extends behind the elbow-joint the pain was so severe that it seemed unbearable. Dry heat and moist heat had no effect upon the pain. When the use of heat generated by an electric light covered by an aluminum cone reflecting the light against the infected area was suggested it seemed unlikely that this could act differently from the other forms of heat that had been employed.

Upon applying the light, however, the excruciating pain disappeared almost at once and since this experience we have employed this form of electric light treatment in hundreds of cases of pain caused by septic infection and quite regularly with results that were eminently satisfactory, not only as regards the relief of pain but also because the remedy assists materially in reducing the infection.

Every hospital should be supplied with this apparatus for the treatment of the above class of cases.

In the field of electric light therapy much careful scientific work is being done at the present time which is certain to explain the benefits which have been derived in an empirical way, and will greatly widen its field of usefulness.

X-ray burns. One of the most distressing conditions encountered in surgery is the X-ray burn.

At first it appears as a simple, slight irritation of the skin with some redness and induration. It may go no further and it may become progressively worse until an entire area of skin, together with more or less of the underlying tissue, has become necrotic. There seems to be a condition of ischemia which reminds one of the appearance of a frozen extremity. The destruction may progress for weeks or months unless it is stopped by appropriate treatment.

Snow, of New York City, directed our attention to the fact that exposing the area occupied by an X-ray burn to strong electric light reflected by an apparatus built on the plan illustrated will result in very rapid and perfect healing.

If the treatment is begun early the skin will not become necrotic; if begun late the excruciating pain will stop almost immediately and healing will begin within a few days without any further treatment.

The light may be used continuously or interruptedly, but always when there is pain.

Dry heat or moist heat without the light rays does not have the same effect either upon the pain or the healing. There seems to be penetration of the electric light waves which is not common to heat waves from other sources. The treatment is easily applied and effective.

CARBUNCLE

At this point it seems proper to discuss another localized infection so characteristic in its appearance as to be classified separately. A circumscribed area of the skin, most commonly upon the posterior surface of the neck, or upon the back, becomes indurated, then red and later purple in appearance, then a number of small perforations occur upon its surface from which a few drops of pus are discharged. The induration is usually one to five cm. in diameter, but it may extend from this focus until a large area has been included. The progress is through the subcutaneous fat. It may be uniform in every direction or extend irregularly, a larger and larger portion of the skin surrounding the original center attaining a honey-combed appearance. The infected area is exceedingly painful and the patient has the general appearance of one who is severely ill. If the disease has existed for a considerable period the center of the area will contain a circumscribed slough of connective tissue saturated with pus opposite each one of the small perforations in the skin. Unless vigorous treatment is instituted the disease usually progresses quite rapidly and its progress is especially favored by motion in the part or by manipulation, which seem to force the infectious material into the surrounding subcutaneous connective tissue. Often resistance has been greatly reduced by the presence of diabetes. Indeed in many of these cases a carbuncle occurs only because of the diabetes, and were it not for this condition the infection which has resulted in a carbuncle would have caused but a very slight circumscribed superficial infection which would have disappeared spontaneously very quickly, had not the tissues furnished such an excellent culture medium for the micro-organisms. In every instance it is important, therefore, to examine the urine in order to determine whether or not the patient has diabetes.

Operative technique. Whenever it can be done the most satisfactory form of treatment consists in making a crucial incision down to the base of the in-

fected tissue, dissecting back the four flaps of skin thus formed and then removing all of the infected parts. The cavity thus formed is then carefully sponged with 95 per cent. carbolic acid and, after a minute, is tamponed with gauze saturated with strong alcohol. This dressing is renewed daily until the wound is perfectly clean, when the edges of the flaps are drawn toward each other and the space permitted to heal by granulation, or if the defect is too large it may be covered with Thiersch skin-grafts.

If this radical operation cannot be performed in any given case, one may usually secure a satisfactory result by employing the following method: From five to ten drops of a 50 per cent. solution of 95 per cent. carbolic acid in glycerine are injected into the base of the indurated area, at points two cm. apart, around the entire circumference of the carbuncle. In this manner an entire circle is made around the diseased area. It is best to use a hypodermic needle and inject from five to ten drops at each point of puncture. The fluid will cause the albumen in the pus to coagulate and ooze out of the perforations in the skin over the center of the carbuncle in the form of a white fluid. This should be sponged away with pledgets of cotton saturated with alcohol so as to prevent cauterization of the surrounding skin with the superfluous carbolic acid. In order to protect the skin against this accident it is well to cover it thoroughly with vaseline before beginning the injections. After the circle has been completed, the surface is covered with a thick layer of gauze thoroughly saturated with strong alcohol, to dilute any carbolic acid which may be discharged later. The patient is kept at rest and the carbolic acid injections may be repeated once or twice if necessary, but usually one treatment will suffice or, if it fails, the radical excision of the infected tissue should be employed. If there is marked improvement the wound is dressed with moist antiseptic dressings daily until healed.

If diabetes is present large quantities of distilled water should be given in order to eliminate the sugar as rapidly as possible, and the diet should be carefully regulated. It is important to give these patients an abundance of proper food and prevent the absorption of products of decomposition from the alimentary canal. Castor oil and mild saline laxatives are well borne.

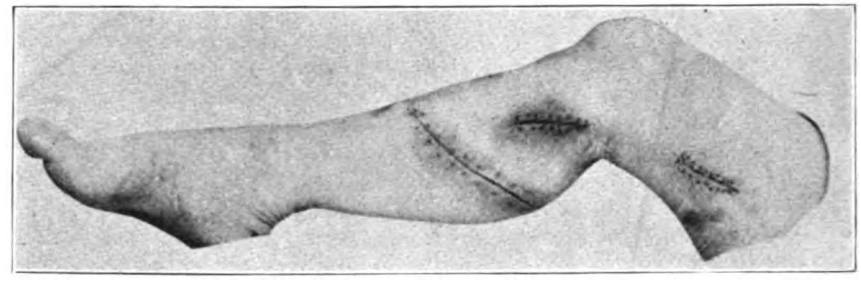
VARICOSE VEINS OF THE LOWER EXTREMITIES

Varicose veins in the lower extremities are accompanied by a great amount of pain, and will usually result, sooner or later, in the formation of an ulcer of the leg, because of the lack of nutrition in the circumscribed areas drained by the lower end of the saphenous veins. If both the superficial and the deep veins are varicose, there will be marked edema of the entire lower extremity, and no operative treatment is of any avail. These patients will progress most comfortably if the bed is arranged so that the lower extremities rest upon an inclined plane regularly at night. This relieves the impaired veins of much of their burden and they have an opportunity to recuperate slightly each night.

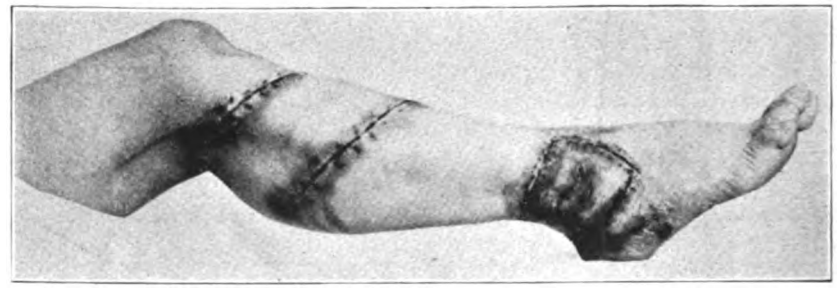
In the morning, before the extremities are lowered, well-fitting elastic stockings should be applied, to support the veins. It is important that the extremities be carefully measured so that the stockings may fit accurately, and that the measurement is taken after the patient has rested in bed for a number of days with the legs elevated, so that all of the edema may have disappeared. If there is only circumscribed or superficial edema, the condition usually depends upon the incapacity of the valves in the superficial veins, namely, the external or internal saphenous, or both. In this event, the patient can usually

obtain permanent and perfect relief if these veins are excised, especially if in addition to such excision all the superficial veins are severed transversely.

Schede operation. A circular incision is made around the leg, cutting through the skin, superficial fascia and all the veins down to the deep fascia a little above the middle of the leg, then uniting the wound in the skin by means of sutures throughout. There is considerable danger of having a constriction of the scar following this operation, but this danger can be avoided by carrying the incision through the skin and superficial fascia and the veins down to the deep fascia, through the circumference, with the exception of an inch opposite the spine of the tibia, and the same distance on the posterior surface of the leg. The superficial fascia and veins between the skin and the



External aspect. Varicose veins of the leg accompanied with ulcer on external aspect of ankle. Treated by excision of long saphenous vein; Schede operation and Nussbaum operation.



Internal aspect. Note that this Schede incision is placed midway between the two on the outer side, and that no incision extends completely around the leg. An Unna's paste cast was applied after removing the stitches.

SURGICAL TREATMENT OF VARICOSE VEINS.

deep fascia at these points may be severed by passing a knife under the skin with the cutting edge downward. This will prevent a circular scar extending entirely around the leg. A further improvement in this operation consists in making the incision obliquely instead of exactly at right angles with the leg. The operation is performed with a constrictor applied to the thigh, so there can be no hemorrhage during the work, and it will not be necessary to ligate any of the veins, the constrictor not being removed until the dressing has been applied and the patient placed in bed, with the extremity elevated.

EXCISION OF THE SAPHENOUS VEINS

The internal saphenous vein is more commonly affected than the external. To determine the extent of the excision the patient should be permitted to

stand erect for a few minutes and the point noted to which the vein is enlarged. It should then be excised to a distance several inches above this point.

Technique. The extremity is elevated and held for several minutes until the veins have become entirely empty. Then an Esmarch constrictor is applied to the thigh high up and vein laid bare by an incision extending over the entire distance through which it is enlarged. The uppermost end is then dissected free, grasped with two pairs of hemostatic forceps and cut between, and the upper end ligated. The vein is then dissected out downward throughout the desired length; the larger communicating branches being caught with forceps and ligated, or they may be left open with safety.

In many cases after the vein has been severed at its upper portion and ligated, the entire enlarged vein can be removed through two or three small button-hole incisions, by using a vein stripper as devised by C. H. Mayo. This avoids making a long cut. In cases in which the vein is not very tortuous this method is very satisfactory.

After the entire vein has been excised the wound is closed and a large antiseptic dressing applied, so that the pressure upon the wound will be uniform and mild. The constrictor is not removed until the patient has been placed in bed with the extremity elevated. The extremity should be left in an elevated position for at least one week after the operation, and then it should be slowly lowered. At the end of the second week a soft flannel bandage may be applied and the patient permitted to be about. It is well for the patient to wear a flannel bandage, applied every morning, for a number of months, before the foot is lowered. It is also wise for him to sleep with the extremity elevated upon an inclined plane so as to relieve the deep veins during the night.

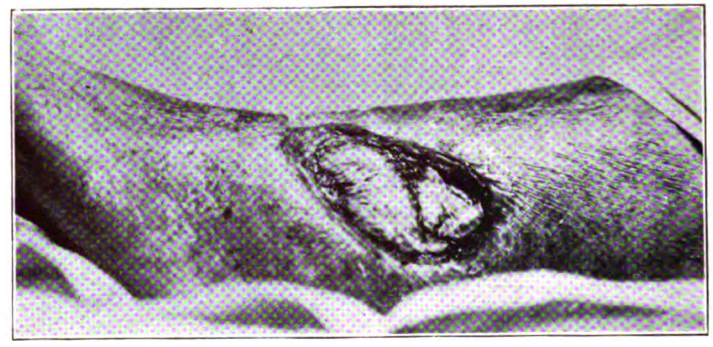
Unna's paste cast. In mild cases of varicose veins of the extremities the following treatment, if applied for a period of from three months to one year, will almost always give great relief, and it will frequently strengthen the veins to such an extent that the patient may remain entirely well for years.

The limb should first be kept in an elevated position for several days and nights in order to empty the veins thoroughly and remove any edema that may be present. The following mixture is then prepared. Place four parts by weight of plate gelatin in ten parts of distilled water, permit this to stand over night, then place in a water bath, heat in this way, stir constantly until dissolved; add ten parts of glycerine while hot, then add four parts of impalpable oxide of zinc powder. Stir constantly.

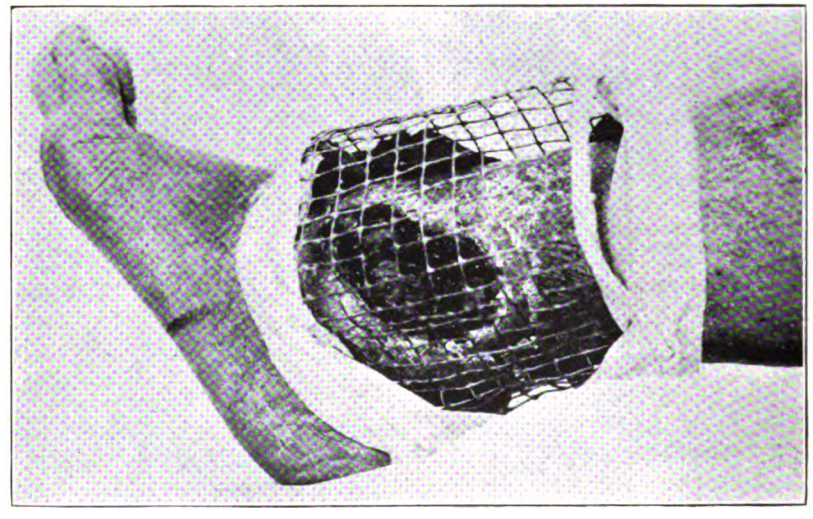
Apply ten thicknesses of gauze about the foot, covering the toes to protect them against contact with the cast. Apply a similar amount of gauze around the upper end of the proposed cast.

If this precaution is not taken the skin will be severely irritated at the upper and lower ends of the cast. It is consequently also important not to apply any of the paste beyond the margin of these protecting gauze bands. The surface of the foot and leg between these two bands is now thickly painted with the hot paste by means of an ordinary large painter's brush. The surface is then covered with a thin gauze roller bandage two inches wide, great care being taken to apply the bandage smoothly. These bandages are now continuously covered with the hot paste until the leg has been covered with about four layers of the saturated gauze roller bandages. The cast remains elastic after it is dry. It may be worn from one to four months, when it should be replaced.

The same method is indicated in the after-treatment of cases that have been operated for the relief of varicose veins, or varicose ulcer.



Varicose ulcer of twelve years' duration. Treated by dressings and elevation of leg for two weeks, followed by skin-grafting. Two skin-grafts shown in position.



The same ulcer, showing wire netting to protect the new skin.

Unna's paste cast applied to support the varicose veins of the leg.

VARICOSE ULCERS

If the veins have been varicose for quite a time, especially in patients working hard, or in those who are likely to subject their extremities to traumatism, an ulcer is apt to form on the lower extremity. So long as the patient remains upon his feet, and so long as nothing is done to relieve the condition in the veins, such an ulcer is unlikely to improve. If, on the other hand, the patient is placed in bed with the lower extremities elevated upon an inclined plane, the pressure removed from the veins and consequently the return circulation favored, the area occupied by the ulcer becomes better nourished and healing is promptly favored. The same is true after excision of the varicose veins, and the circular incision through all of the superficial veins, provided the ulcer has not existed too long and has not become of such size that its covering with epithelium is impossible. The floor of the ulcer will then become composed of a mass of hard, connective tissue, the result of an attempt at cicatrization of the ulcer, and it is difficult for epidermis to grow over this surface.

In these advanced cases it is better to excise this connective tissue and cover the entire surface with Thiersch's skin-grafts, at the same time that operation is performed for the relief of varicose veins. By the time the wound of the latter operation is healed the skin-grafts will have firmly adhered to the raw surface and the patient at once relieved of the ulcer.

Nussbaum operation. In varicose vein cases with an ulcer of long standing, we frequently do the operation devised by Nussbaum, in addition to making an excision of the internal saphenous vein and doing the Schede operation. This consists in making a circular incision around the ulcer area about one inch from its edge, extending down through the skin and superficial fascia to the deep fascia, then suturing the wound throughout. This cuts off all of the veins going to and from the ulcer area. If the ulcer is large it can be skin-grafted, as suggested above, after the Nussbaum operation has been completed. In cases of small varicose ulcer, in which the superficial veins are not prominent, we frequently just make the Nussbaum operation, without excision of the internal saphenous vein. This operation has proven very satisfactory.

SKIN-GRAFTING

This procedure is indicated wherever a surface is deprived of a sufficient amount of skin to make a spontaneous covering impossible, or in cases in which it would require too great a period of time, or in which the skin formed in this manner would not be sufficiently substantial. It is also indicated after the removal of tumors in which so much of the overlying skin has to be removed as to make it impossible to bring the edges properly together. In these instances the operation of skin-grafting may be carried out at once, provided the hemorrhage be sufficiently stopped at the time of the operation. The same is true after the excision of troublesome scars after burns or injuries.

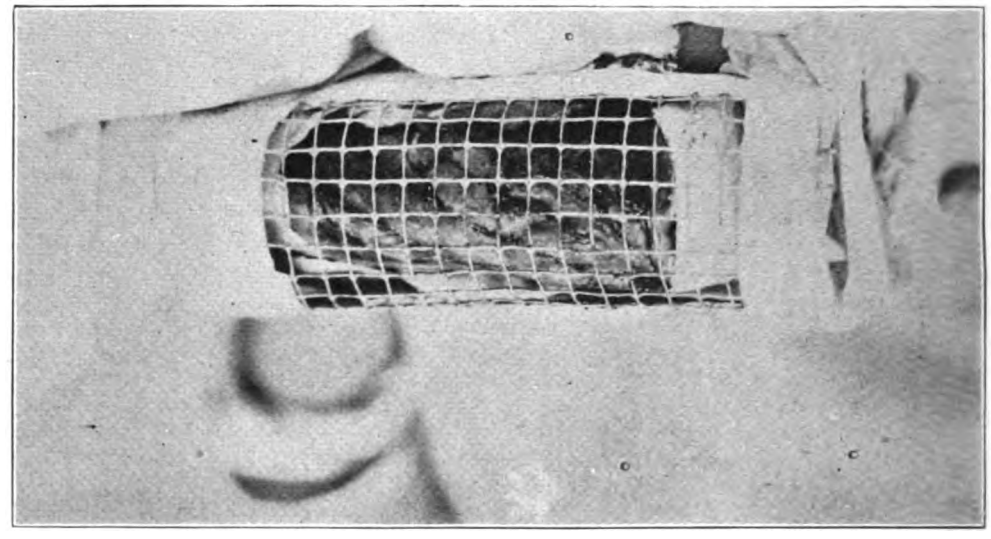
Technique. The success of the operation depends upon,

1. Absolutely aseptic conditions.
2. Securing a bloodless surface on which to graft the skin.
3. The accurate application of the skin-grafts; and
4. The fact that the grafts have not been injured by contact with any antiseptic solution between the time of their removal from the normal skin and that of their application to the raw surface.

The area from which the skin is to be removed should be prepared as carefully as though any other operation were to be done. The most convenient place from which to obtain skin is the outer surface of the thigh. The skin

is removed by means of a sharp razor, preferably with a wide blade, held parallel with the surface of the extremity, being permitted to slide upon the thigh. The thickness of skin to be removed is regulated carefully by the method of holding the razor. The skin should be stretched so as to make it as tense as possible. Then a layer should be shaved off by means of a sawing motion. This layer should contain the epidermis and a thin portion containing the tops of the papillæ.

The portion cut is permitted to fold itself upon the surface of the razor until a sufficiently long strip has been removed to extend across the ulcer or raw surface to be covered. This may be calculated very easily, so that each successive strip will extend quite across the part. Neither the skin nor razor, nor the surface to be grafted upon, should be wet. If this precaution is taken union between the surfaces will take place almost instantly.



PROTECTION OF SKIN GRAFTS.

Shows how skin grafts are protected by a wire mesh frame which allows of dry healing, no dressings to disturb the grafts, and they can be inspected frequently.

A large raw surface following complete mammectomy covered with skin grafts, three weeks after grafts were applied.

The plan practised so long of covering the razor, the skin and the portion to be grafted with normal salt solution reduces the chances of rapid and perfect union.

In order to spread the graft over the area to be covered most conveniently the sharp edge of the razor should be placed in contact with this surface, and while the graft is being pulled off this edge by means of a needle fastened in a pair of hemostatic forceps the razor is slowly moved across the surface. In such manner the graft will be almost perfectly spread without any further manipulation. The edges may be still further adjusted by means of a pair of needles fastened in hemostatic forceps. It is well to let the delicate edges of these grafts overlap a little. After the entire surface has been covered with a series of these sections it is protected by the application of a network of rubber tissue strips from two to three millimeters in width. These will at once protect the underlying skin-grafts and at the same time make it possible for drainage to take place between these pieces. A dressing of sterilized gauze is placed over these strips and held in position by means of rubber

adhesive straps. A thick layer of absorbent cotton is then put over all and held in position by means of a soft roller bandage.

Of late we have used a method of protecting skin-grafts which is far superior to any previously employed. After the skin-grafts have been applied, a wire mesh "basket" is fitted so that no part of it touches the wound, and its edges are well padded with gauze. In this position the "basket" is held in place by adhesive strips, first passing it through a flame, in order to sterilize it. A layer of sterile gauze is then placed over the wire and a gauze bandage holds all in position. The grafts may be inspected from time to time without disturbing them.

After-treatment. The wound is not disturbed for one week, when the dressings are thoroughly moistened and removed without disturbing the grafts. It is important that the dressings be not pulled upon as at this time the attachment between the grafts and the raw surface is still very slight. If the dressing is performed carelessly enough harm may be done to destroy a portion of the new skin.

After the dressing has been removed, together with the rubber protective strips, a similar toilet to the one first applied should be used and at the end of a second week, when this is again removed, the wound is usually found perfectly healed. If this plan is carried out it will not be possible to distinguish, after the wound has healed, the different grafts applied; the surface being perfectly smooth, there will be no traction thereon, and it will be sufficiently firm to bear the ordinary abuses to which the skin is exposed.

NERVE SUTURE

It is generally accepted that the regenerative sheath of a nerve is the neurilemma, and that all nerves which are provided with a neurilemma are capable of repair under favorable conditions, but that those without a neurilemma are incapable of repair under any circumstances. The nerves of special sense are not provided with a neurilemma, so consequently they have no power of regeneration, no matter how carefully they may be adjusted.

For some unknown reason sensory nerves seem to regenerate much more rapidly and under less favorable conditions than do motor nerves.

Nerve suturing should be employed where a nerve is severed accidentally during an operation; where a portion of nerve had to be excised, together with some malignant growth; where a portion of nerve has been severed or destroyed by traumatism; and occasionally in cases in which a nerve has been caught between the ends of a fractured bone and destroyed by the pressure due to the formation of callus.

If the nerve be sutured immediately after being severed the operation simply consists in adjusting the nerve ends and then applying a sufficient number of fine catgut sutures to hold them in perfect coaptation. It does not matter whether these sutures are passed through the trunk of the nerve or simply include the sheath. The important point is to have the ends of the nerve carefully approximated. It is well to adjust over the line of suture in the nerve a convenient piece of fascia, which can be obtained in the wound by means of a few fine catgut sutures.

If a portion of nerve has been destroyed by some traumatism the difficulty is easily managed, as one of the principal conditions to be obtained in order to secure success is the absence of tension upon the nerve ends. In cases in which the ends cannot be adjusted absolutely without tension the distance between them should be bridged over in the following manner:

Technique. The nerve ends are cut off squarely; then a very fine catgut suture is passed back and forth between the divided extremities, each time

passing through the end at a little distance from the previous point of perforation until a bundle of catgut has been produced approximately the size of the nerve being sutured. This should be applied so that there is absolutely no tension upon the sutures, which should lie loose between the two nerve ends. When a sufficient amount of this catgut has been thus arranged the ends are tied and the entire bundle of catgut, together with the two nerve ends, is covered by reflecting a flap of fascia over them and attaching them to some of the soft tissues beyond by means of a few fine catgut sutures. By this method we have secured perfect functional results where as much as three inches of the ulnar nerve had been destroyed by a gunshot wound, and in a number of other cases we have had equally satisfactory results with this form of grafting nerves by means of intervening catgut sutures. If the nerve has been severed for a period of time the conditions are still further complicated because the ends of the nerves are now covered with connective tissue, and in order to secure satisfactory functional results it will be necessary to absolutely remove all of this connective tissue. The tendency in these operations is always to cut away too little of such tissue in order not to increase the distance between the ends too greatly. Many failures are undoubtedly due to this disposition.

With section through a relatively healthy nerve and a distance of an inch or more between the ends the chances for a satisfactory functional result are much greater than with the ends directly sutured together, and wherein all of the connective tissue which has resulted from the healing of the nerve stump has not been removed.

We would, therefore, emphasize the importance of cutting away a sufficient amount in cases in which nerve grafting is practised a considerable time after the nerve has been severed. Here again it is important to bear in mind that a condition of tension is the worst possible one to be obtained in nerve suturing.

The surgeon will often encounter no small amount of difficulty in finding the nerve ends directly, if the operation is performed some time after the injury has occurred, for the traumatism itself and the subsequent healing has usually disturbed the relations to such an extent that the nerve cannot readily be discovered by searching for it in its normal anatomical position.

The proximal nerve end is usually considerably enlarged and may, therefore, be found more easily, as it can be felt through the other tissues. This is not the case with the distal nerve end, however, which is rarely enlarged at all. It is always wise in these cases, if the nerve end is not found at once, to locate the nerve in its normal position at some distance from the point of injury and then follow it down to where it has been severed. It is not necessary to loosen the nerve entirely from its attachments in doing this. All that needs to be done is to free its superficial surface and follow this down to the end.

If the nerve has been included in callus, resulting in a paralysis of the portion beyond the seat of the fracture, and was not injured directly at the time of the fracture, then the paralysis will have come on slowly and not have existed directly after the time of the injury. For this reason it is important to obtain a perfect history, for it frequently happens that a nerve is surrounded by callus, and as this increases in firmness the pressure upon the nerve results in a paralysis. If this nerve is laid bare and the callus chiseled away the nerve may be released from its grasp, and unless it has been held in the callus for a lengthened period its function will be restored. In order to prevent again becoming compressed in the callus it should be carried to some distance from the original point of incarceration and surrounded by some of the soft tissues. The same precaution should be taken if the nerve has been en-

tirely severed and the ends caught in the callus. Too much stress cannot be laid upon the importance of carefully observing cases of paralysis following fracture, as much greater success follows an early rather than a late operation.

Prognosis. Where the nerve is sutured directly at the time of the injury, both the immediate and the remote results are good. Sensation may return within a few hours after the operation, and motion will begin to return within a few weeks, and may be perfect within three months. If the operation be performed several weeks or months after the injury, then sensation may return within a short time, but unless the action of the muscles is maintained by means of electricity or massage atrophy is likely to occur and the patient will recover but slowly from the paralysis of motion. In some instances the recovery from paralysis of motion may occur as late as one or two years after the operation, and the functional result may continue to improve for a very long time thereafter. The prognosis is relatively much better the nearer the terminal end of the nerve the injury occurs; consequently the suturing of one of the large nerves does not give nearly so good a prognosis as the smaller ones.

Transplantation of nerves. During the past few years considerable progress has been made in transplanting nerves, or portions of nerves, to supply other nerves which have lost a portion of their substance as the result of traumatism or operation. This plan has recently been extended to the transplanting of a portion of a normal nerve into the edge of a nerve which has become useless as the result of central disturbance, such as poliomyelitis. It is claimed that in this manner the portion of the nerve which remains intact will carry on the function of the entire nerve, while the portion attached to the useless nerve will in time restore the latter to a fair amount of activity.

Recently the loss of function of a severed facial nerve has been restored by anastomosing it with the spinal accessory nerve. Several operators have reported excellent results from this operation. The important points about the operation are to secure a good end-to-end anastomosis of the nerves without any tension, and then to imbed the anastomosed portion of the nerves in the belly of the digastric muscle or sterno-hyoid muscle, so as to avoid unnecessary scar tissue about the anastomosis.

TENDON SUTURES

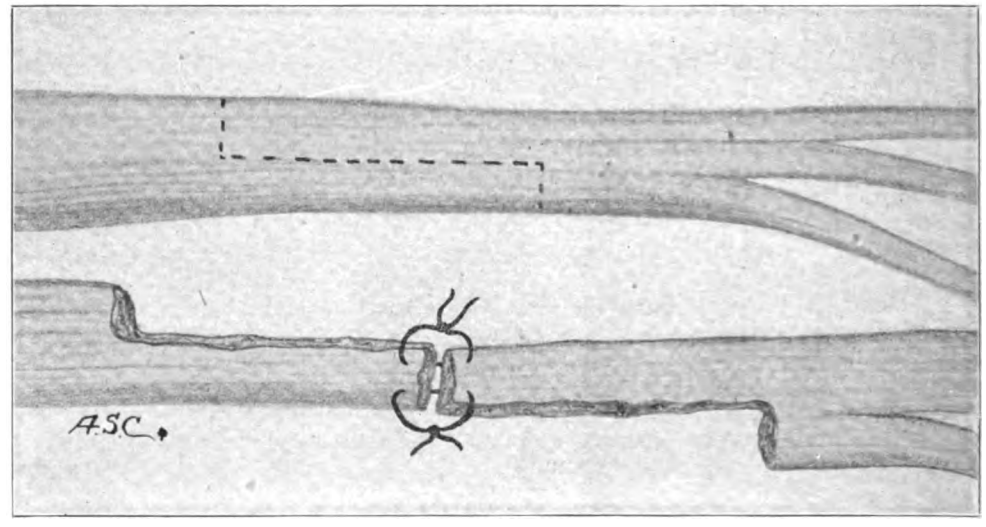
If a tendon is severed and sutured immediately the result is almost invariably satisfactory, provided the wound remains aseptic. It does not matter what method of suturing be employed so long as the tendon ends are in apposition. It is, however, best to insert the sutures in such a manner that they cannot readily split the tendon end longitudinally. This is best accomplished by passing the suture into the tendon end, then out through one side, then passing it a short distance across the tendon, and then into the tendon again.

If a considerable portion of a tendon has been destroyed the ends may be united in the manner described for uniting nerve ends at a distance. The functional results in these cases are surprisingly good. We have repeatedly united tendon ends more than six inches apart with perfect functional results where theoretically one could expect nothing but failure. It is, however, of the greatest importance to avoid tension.

In cases in which a tendon is contracted it may be lengthened by splitting longitudinally in halves, then cutting off one of these segments in one direction at the end of this longitudinal incision and the other segment in the opposite direction at the other end, then stretching out the tendon and uniting the two segments so produced. In this way any desired amount, which does not exceed double the original length, may be very easily obtained. The ten-

don very quickly becomes firm and the functional results are highly satisfactory.

If the operation is performed immediately after a tendon has been severed the greatest difficulty is encountered in finding the tendon ends, which usually retract a greater or less distance within their sheaths. If a closed pair of forceps be passed up through the sheath until it reaches the point at which the tendon end can be felt and then opened, this end can usually be caught and brought down. If this cannot be done an incision may be made opposite the point to which the tendon has retracted and a stitch may be passed through the tendon end and threaded in the eye of an old-fashioned probe, and this carried through the sheath of the tendon, and then by drawing on the suture the tendon end may be brought down and united to the distal end. If the end cannot be located the sheath may be split until it is reached. It is then brought down and united and the sheath sutured over it with fine catgut



OPERATION FOR LENGTHENING CONTRACTED TENDONS.

To the left is shown the incision, which may be lengthened to any desired extent. To the right is shown the method of suturing the lengthened tendon.

sutures. Usually this does not result in any adhesions between the sheath and the tendon unless the wound becomes infected.

In applying sutures to tendons tension should be avoided and the sutures should never be tied tightly enough to cause pressure-necrosis, as tendon is a tissue not well supplied with blood, and consequently easily injured in this manner.

Healing may be further favored in applying the dressing with the extremity in the most favorable position for obtaining a relaxation of the muscles belonging to the tendons which have been sutured.

TENDON TRANSPLANTATION

In patients suffering from infantile or spastic paralysis it is often possible to obtain remarkably satisfactory functional results by transplanting the tendon of a muscle not affected by the paralysis to the insertion of a tendon of a muscle which is affected. This may be best illustrated in the talipes equino-varus of infantile paralysis, but the same principle applies elsewhere.

Here the equinus position may be overcome by lengthening the tendo achilles, while the deformity due to turning in of the foot is corrected by transplanting the lower attachment of the tendon of the tibialis anticus muscle from the inner to the outer side of the foot. An incision 2 cm. in length is made just below the anterior annular ligament of the ankle, directly over the tendon of the tibialis anticus muscle. A blunt hook is passed around this for the purpose of making traction. Then a similar incision is made over the attachment of the tendon to the inner surface of the cuneiform bone. The tendon is then loosened from its lower attachment, which may be facilitated by drawing gently upon the blunt hook. A third incision is then made over the point of insertion of the peroneus brevis to the outer surface of the fifth metatarsal bone. The space between the first and third incision is then tunneled with a pair of blunt forceps, and the end of the tendon drawn through this channel and carefully attached to the tendon of the peroneus longus by means of fine chromicized catgut sutures near the point of attachment of the latter muscle, or to the point of attachment of the peroneus brevis. The three wounds are then sutured and the foot dressed in a plaster-of-Paris cast at a little less than a right angle. The splint is worn for three months. In our experience this operation has given very satisfactory results.

It is, of course, important that the muscle to which tendon is to be transplanted be in a fairly normal functional condition.

It is unnecessary to carry the application of this principle through the various operations in which it may be employed as any one sufficiently familiar with anatomy may select from the muscles those best suited for the purpose of substitution for those which are completely or partly paralyzed.

TUBERCULOSIS OF THE JOINTS

This condition is characterized by its slow beginning, by its usual limitation to one joint, by the tendency to fixation of the joint, and, later, by atrophy of the muscles, both above and below the affected part. Its location is often determined by a traumatism, although this cannot always be established, and where there is a history of injury the surgeon cannot always exclude the possibility of coincidence.

Usually it is secondary to tuberculosis of the respiratory or alimentary tract, the tonsils or the lymph glands, the bacilli having been carried to the vicinity of the epiphyseal line of the bones or to the joint surfaces by the blood-stream. It is therefore of the greatest importance that the surgeon's attention be primarily directed toward the improvement of the patient's general health, which can be best accomplished by bettering his hygienic surroundings, nutrition and habits of life; and by administering tonics and concentrated foods and some form of creosote. Above all things he should not be permitted to continue living under the conditions which primarily gave rise to his disease. These points are of great importance, not only in obtaining a recovery from the immediate disease, but also for the purpose of securing permanency of cure. It is virtually always necessary to change the dwelling of these patients, if not the climate; to change their food, regulate their hours of rest, and frequently their occupations. This having been done, the treatment of the joint involved will depend upon its location and the extent to which the disease has progressed; but in any case as nearly complete rest as possible for the joint is most to be desired, especially if this can be obtained without confining the patient to bed. If the disease is in an incipient stage, rest alone, with the conditions described above, will usually suffice to produce a recovery.

A light cast made of plaster-of-Paris, very carefully constructed, and strengthened by the incorporation of thin strips of tough wood, such as are used in the manufacture of market baskets, is usually the most desirable dressing, unless the patient can afford a similar dressing made of aluminum. The cast should be applied over some elastic woven material, arranged in a double layer, so that any friction will not be directly against the skin, but against the second layer, which will remain free.

If the ankle or the knee-joint is involved, it is best to draw two closely fitting stockings over the extremity.

The cast should be worn for a number of months after the joint is apparently perfectly well.

HIP-JOINT TUBERCULOSIS

In the hip-joint the treatment by fixation with a plaster-of-Paris cast should be supplemented by weight-and-pulley extension, to be applied at night, for a period of at least two years after the joint has apparently fully recovered, as this seems to prevent recurrence, deformity, to increase the comfort of these patients, and to remind them of the necessity of avoiding traumatism for a considerable time. The extension is made by applying a strip of rubber adhesive plaster from eight to twelve centimeters in width, to the inner, and outer surface of the entire thigh and leg, and holding them in place by a roller bandage. These plaster strips are attached to the cord which passes over the pulley to the weight, by means of two cords attached to a cross-piece of wood eight to fifteen centimeters in length. The lower end of the bed should be elevated from ten to twenty centimeters, in order to secure counter-extension from the weight of the body. The weight employed should be from one-tenth to one-fifth of the weight of the body, the correct amount being determined by the comfort of the patient. It is well to begin with a light weight and increase gradually.

If rest and hygienic measures alone are not sufficient to obtain a cure, which may usually be determined by an increase in the pain, or that the swelling did not subside, or that a point of fluctuation appears in the vicinity of the joint, then it will become necessary to open the joint and remove the diseased tissues, consisting of portions of the capsule, the synovial membrane and cartilage of the joint, and in advanced cases usually some portion of bone.

Often the radical operation may be postponed until the treatment by means of injection with a mixture of iodoform and glycerine has been tried. This will be described presently.

Technique. In children, the least possible amount of tissue should be removed, as in a great majority of cases this will suffice to produce a cure quite as frequently as a more extensive operation, and because the less tissue removed the less will be the deformity, and likelihood of impairment in the future growth of the extremity.

In adults conditions are somewhat different. Here an excision of a sufficient amount of bone to insure anchylosis is much more likely to cause a satisfactory outcome, especially in the hip- and knee-joints, both as regards permanency of cure and preservation of function.

The anchylosis favors strength and the absence of motion gives freedom from pain. The permanency of cure depends to no small degree upon the fact that any slight focus of infection which may have been overlooked is much less likely to be kindled into activity if the joint is placed perfectly at rest by the anchylosis. Moreover, the excision of a sufficient amount of bone to secure this condition increases the likelihood of a complete removal

of all the diseased tissue. After the diseased tissue has been completely removed, the raw surfaces should all be thoroughly and repeatedly swabbed with a ninety-five per cent. solution of carbolic acid for a period of five minutes, the superfluous acid being washed away with strong alcohol. After this, it is well to apply strong, compound tincture of iodine to the entire surface, and then a ten per cent. solution of iodoform and glycerine, after which the wound is to be closed with deep sutures of catgut and superficial sutures of any desired material. If any doubt exists as to the aseptic state of the joint when the operation has been completed, it should be freely drained with rubber tubes or with iodoform gauze passed transversely through the articulation. The joint is then covered with a large dressing and immobilized by plaster-of-Paris or splints.

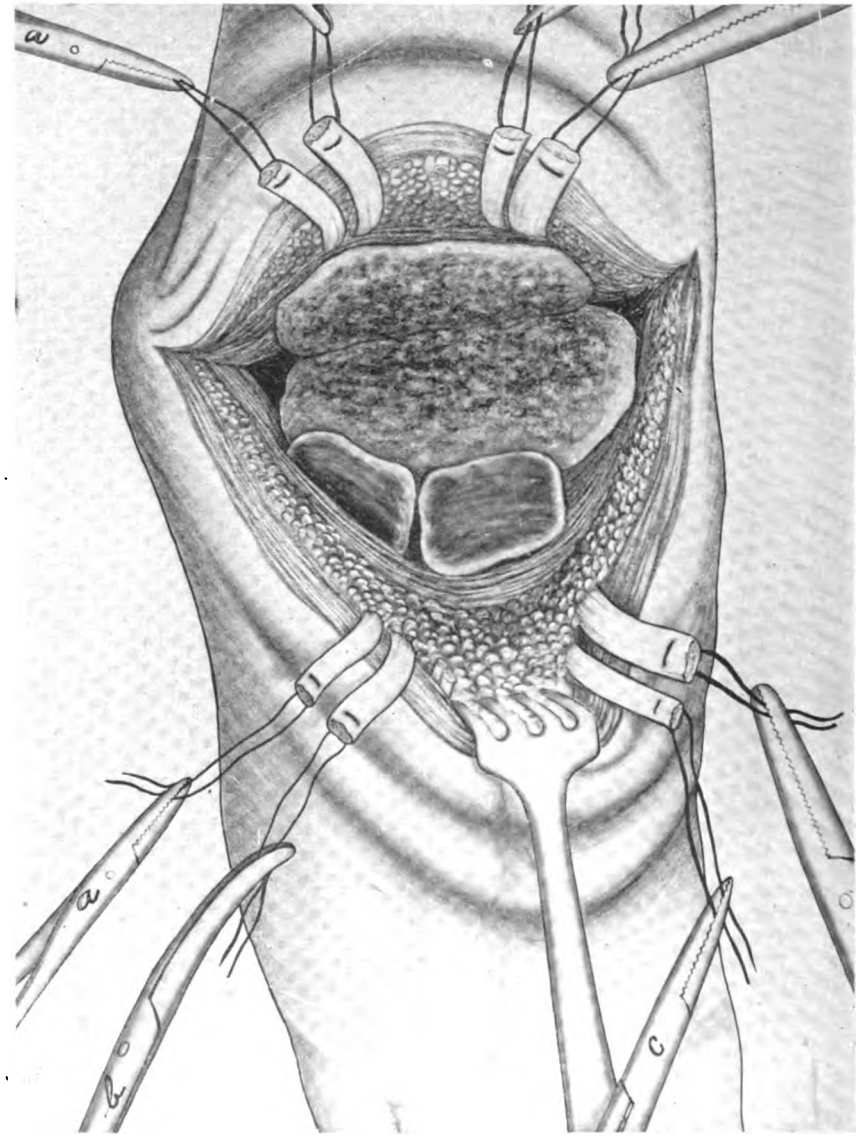
All the joints of the upper and lower extremities, with the exception of the shoulder and the hip-joint, are operated after the application of an Esmarch constrictor. This facilitates the work greatly and it is an easy matter to avoid all the important blood vessels during the operation, hence it is not necessary to remove the constrictor before suturing the wound and applying the dressing. If, however, there is any fear in the mind of the operator of hemorrhage later, it is always best to remove the constrictor before suturing the wound, carefully grasp all bleeding points with artery forceps and ligate them before closing the wound.

RESECTION OF THE ANKLE-JOINT

Nothing has been said concerning the operation itself in connection with each joint, because the typical operations outlined in every text-book are quite as satisfactory as any we may describe, with the exception of the method for resection of the ankle-joint. The operation which is here outlined is not generally practised, but any surgeon who has once tried this mode will always continue to employ it, as it insures a most satisfactory approach to the diseased tissues, and the results are likewise most satisfactory, both as regards the functional effects and permanency of cure. This is true even in cases that seem quite hopeless with any other method.

Technique. An incision is carried directly across the anterior surface of the ankle from malleolus to malleolus through the skin, superficial and deep fascia and the sheaths of all of the tendons in the course of the wound. Externally the peroneal artery and nerve should be avoided, as well as the tendons of the peroneal muscles, which may readily be drawn out of the way. Internally the posterior tibial artery and nerve are protected. Each tendon is then lifted up in the incision and transfixed with two fine catgut sutures from one to two centimeters apart. These sutures are caught in similar artery forceps for purposes of identification, then the tendon is cut transversely between these sutures. After all the tendons have been disposed of in like manner, the joint is opened by a free transverse incision and the sole of the foot forced back upon the calf of the leg. In this manner the entire joint is opened freely, so that all diseased tissue may be removed. After this has been accomplished, as described in connection with the treatment of tuberculous joints in general, the foot is placed in position, the tendons carefully adjusted, which may be done with great ease, because the two sutures upon two corresponding tendon ends are fastened to hemostatic forceps of the same pattern. Each tendon is carefully sutured and a fine stitch placed in the fascia to cover the line of suture in the tendon. Then the skin is sutured over all. If drainage seems necessary, it is applied through and through, and even in cases apparently requiring no drainage, we have usually passed a few strands of catgut or silkworm gut entirely across the foot, permitting the ends to protrude from the

lower angles of the wound so as to drain the serum which may be secreted by the large surface during the first few days. A large dressing is applied and the foot immobilized in a position at a little less than a right angle.



EXCISION OF ANKLE WITH TRANSVERSE ANTERIOR INCISION.

Similar forceps being placed upon sutures inserted in the two free ends of each cut tendon for identification.

After-treatment. The foot is elevated in order to favor return circulation. If drainage has been used, this is left in place from one to two weeks. The dressing is not changed, unless indicated by the discharge, for a week or ten days, in order to avoid moving the foot, and after that as seldom as possible for the same reason.

Prognosis. The prognosis is very good after this operation. The free exposure of the surfaces insures thoroughness, and consequently the cure is usually permanent. The ankylosis of the surfaces immediately in the field of operation does not interfere with movement because the tarso-metatarsal joints will supply the motion necessary. The tendons unite readily and act normally. There is no operation for the relief of joint tuberculosis that has given us more satisfaction than this. With this method it is often possible to obtain a useful foot in cases which formerly could only be relieved by an amputation.

At the present time it is possible to obtain artificial limbs, in case of amputation at the lower third of the leg, so excellent that unless one can secure a good result after a resection of the ankle an amputation is to be preferred.

TUBERCULOSIS OF THE SHOULDER, ELBOW AND OTHER LARGE JOINTS

The shoulder-joint deserves some special attention, as it is least useful when ankylosed, and consequently an operation for the relief of tuberculosis must here be performed in a manner that will prevent ankylosis. This may be accomplished by stripping back the periosteum upon the shaft of the bone, then cutting away the head, together with two or three centimeters of the shaft and afterwards covering the end of the bone with the periosteum, which has been stripped back, together with some fascia.

The elbow-joint. In the treatment of tuberculosis of the elbow-joint, the social and economical condition of the patient must be considered. An ankylosis at a little less than a right angle will produce the most useful and the most powerful arm for a laboring man or a mechanic, but the awkward position will interfere with the patient's appearance. If one desires the greatest amount of power and usefulness, the arm should be dressed at a little less than a right angle. If he is willing or desirous to sacrifice these qualities for the sake of obtaining greater beauty, a sufficient amount of bone should be removed to insure a movable joint, the ends of the bones being again covered with soft tissues.

The wrist-joint should be dressed as nearly straight as possible.

The hip-joint. The hip should be dressed with the extremity in the abducted position, the foot extending as nearly straightforward as possible, both inversion and eversion being avoided. This precaution considerably overcomes the tendency to shortening. This position may be secured by means of a plaster-of-Paris dressing, or by a weight-and-pulley extension, combined with the use of a Hodgen's splint with a foot-piece attachment, which will insure the vertical position of the foot.

The knee should be dressed in a slightly flexed position, because this secures the greatest ease in walking.

TUBERCULOSIS OF THE SACRO-ILIAC JOINT

Tuberculosis in this joint is characterized by lameness, which at first is apparent only during, or more frequently the day after, severe exertion.

A misstep or a quick motion is likely to give rise to pain. The patient usually at first imagines the pain to be located in the hip, and percussion over the great trochanter is apt to give rise to pain. There is, however, no suffering upon motion of the hip, flexion, extension and rotation being normal and painless, unless the motion is very sudden and sufficiently violent to affect the ilium. There is no pain upon pressure over the hip-joint, but pain is present when pressure is made over the sacro-iliac articulation, or when compression of the pelvis is made. There is frequently an evening temperature.

Technique. The same principles obtain here in the treatment of tuberculosis as in the other joints. In many hygienic measures and rest will result in

a cure. Injection with iodoform emulsion gives very favorable results, and should a sinus be formed, cauterization frequently produces a cure. It is rather more difficult to obtain a thorough removal of all the diseased tissue where the joint is extensively involved and in which the measures mentioned above have failed to produce a cure, than in tuberculosis of other joints.

In these cases it becomes necessary to avoid injuring the sciatic nerve if the bone is so extensively diseased as to approach this structure. Our own results have been best when we have thoroughly removed all of the diseased bone, then treated the cavity with strong carbolic acid, then with alcohol and then tamponed with iodoform gauze, which was removed after a week, when the cavity was treated with strong tincture of iodine and sutured secondarily.

The patient should be kept in bed until the tissues have become firm, because motion is likely to disturb the newly-formed tissues and cause a recurrence.

After-treatment in cases that do not heal primarily. Should the wound not heal primarily, the sinuses may be stimulated by the injection of strong compound tincture of iodine, ninety-five per cent. carbolic acid, followed with strong alcohol, or two to ten per cent. solutions of nitrate of silver in water.

It has been claimed that these sinuses will heal much more rapidly if exposed daily to the influence of the X-ray for a period of fifteen minutes at a distance of twelve to fifteen centimeters. We have not tried this method in a sufficient number of cases to be entitled to an opinion, as the possibility of coincidence must not be overlooked.

In a number of instances we have seen rapid and permanent healing after touching these sinuses thoroughly with the actual cautery, the point of the cautery being introduced into the sinus, permitting the heat to radiate to the surrounding tissues. This is much better than to attempt to touch all of the infected parts directly. A rod of iron the size of a lead-pencil, heated to red heat in a gas or alcohol flame, or in a coal fire, or a tinsmith's heater, serves this purpose admirably. Before introducing this rod into a sinus, the direction and depth of the latter should always be determined by means of a probe, in order that the cautery may be readily introduced in a manner to insure the cauterization of the sinus throughout its course without destroying healthy tissue.

MIXED INFECTION IN TUBERCULOUS BONE AND JOINT DISEASES

So long as the entire infection is due to the bacillus of tuberculosis, the progress of the disease is slow, and except where the pressure, within the capsule of the joint, gives rise to severe pain, the patient usually does not give the impression of being very ill, unless the affection is complicated with other troubles, such as tuberculosis of the lungs. If, however, the disease becomes complicated by infection of the abscess with other pathogenic micro-organisms, the condition of the patient at once becomes much more serious. He acquires the appearance of one suffering from a degree of sepsis, depending upon the form and extent of the infection, and his general state becomes rapidly more grave, usually first recognized by the characteristic hectic flush.

It is a singular fact which has been constantly demonstrated clinically, that a tuberculous abscess may open spontaneously and discharge through a sinus for weeks, months, or even years, without becoming infected with other pathogenic micro-organisms, while a similar abscess opened by an incision may become infected almost at once. This is of great practical importance, as it illustrates the point that by a simple incision the surgeon may in a moment change a harmless tuberculous abscess into an exceedingly harmful mixed infection.

In any case, then, in which it seems impossible to remove all the tuberculous infection and change a tuberculous abscess into a clean wound, it seems important to follow a method which removes the tuberculous pus from the body without substituting for it a worse condition. This may be accomplished by lifting up a fold of the adjoining healthy skin for a distance of three to five centimeters and piercing the abscess with a trocar two or three millimeters in diameter, permitting the tuberculous pus to escape, and then injecting the cavity with a ten per cent. solution of iodoform in glycerine, sterilized. (The iodoform should be put into an open bottle with a cotton stopper, and placed in a water bath. The water should be permitted to boil around the bottle for one hour. This will liberate enough free iodine to accomplish the sterilization.)

IODOFORM-GLYCERINE INJECTION OF TUBERCULOUS JOINTS

Differing opinions. There is much difference of opinion regarding the value of iodoform-glycerine mixtures injected into the cavity of tuberculous joints. Its advocates show a large number of perfect and permanent recoveries following this form of treatment, while its opponents claim that all of these cases belong to a class which would have healed with the same results in about the same time had they been treated with rest and ordinary hygienic measures. Both the advocates and the opponents of this form of treatment represent some of the ablest and most experienced surgeons, and we are not prepared to decide which faction is right, although our own experience is strongly in favor of this method in the early treatment of tuberculosis in all joints, except the hip. There are, however, several points in the technique which should be rigorously obeyed:

Rules of procedure. 1. The trocar should never be plunged directly into a joint, but always obliquely underneath a fold of skin, so that a valve will be formed when the instrument is withdrawn, which will prevent the infection of the joint cavity with pathogenic micro-organisms.

2. The amount of manipulation should be limited so as to prevent the opening of lymph spaces through which secondary infection might occur.

3. The amount of pressure employed in injecting the solution should be moderate in order to avoid rupturing the capsule of the joint and forcing the fluid, together with tuberculous contents of the joint, into the tissues surrounding.

4. If the treatment does not result in distinct benefit to the patient after five or six applications, from one to two weeks apart, it should be abandoned.

5. The patient's general and hygienic surroundings must be improved to a favorable standard.

6. As much as possible of the fluid contained in the joint should be withdrawn before the injection is made.

7. Except in the shoulder and sacro-iliac joints, an Esmarch constrictor should be applied before the joint is tapped, and left in place until a large dressing has been fitted and held in position by a snug bandage, which will prevent hemorrhage into the joint.

This last precaution is not generally employed, but we are confident that it is of distinct benefit.

In applying the constrictor for this purpose the same precaution should be taken against injuring the large nerves as in other operations. A large rubber tube or a broad rubber bandage should be used in preference to the narrow rubber band usually employed. If a small rubber tube or a narrow band is used, the extremity should first be protected by wrapping with a towel, folded upon itself at least four times.

In inserting the trocar into the various joints, aside from carefully securing a valve formation of the canal, the surgeon must avoid injuring important

anatomic structures in the vicinity of the joint, and the point of the trocar must be directed so that it will not injure any joint surface.

In the smaller joints a very small amount of the solution may suffice, the quantity depending upon the tension caused by the fluid injected, which should never be sufficiently great to endanger the capsule or produce severe pain. In the wrist-joint the introduction of the fine trocar used is usually not followed by the evacuation of any fluid, and here the injection of two to four cubic centimeters will often be followed by perfect results.

In the knee-joint it is often possible to withdraw several ounces of fluid, and in these cases it is safe to inject as high as thirty or forty cubic centimeters of the iodoform-glycerine solution.

In the treatment of psoas and iliac abscesses much larger quantities of tuberculous pus are frequently withdrawn through the trocar, and it is safe to inject from thirty to fifty cubic centimeters of a ten per cent. solution of iodoform in glycerine.

To prevent too great tension in injecting this solution into tuberculous joints, it is well to attach a soft rubber tube to the trocar with one end, and to a glass syringe holding thirty cubic centimeters with the other, and then pour the solution into the glass syringe and introduce the plunger after the rubber tube and the trocar have become filled with the solution spontaneously.

In forcing in the plunger, if the pressure becomes too great, the intervening rubber tube will dilate before a sufficient amount of pressure has been exerted to injure the capsule of the joint. In injecting the large joints a large trocar is used, but in the smaller joints the trocar should be just large enough to permit the transmission of the iodoform mixture.

Until the pain has subsided the patient should be kept at rest, then a moderate amount of exercise is useful. The injection is repeated every one to two weeks at first, and less frequently later.

New preparations. More recently we have frequently used two mixtures in place of the above one of iodoform in the treatment of tuberculous joints and tuberculous abscesses. These mixtures have been used with remarkable success by Professor Calot, of France, and we are able to confirm his observations. They are applied precisely like the above iodoform mixture. No. 1 is used in all cases in which the joint contains liquid accumulations, while No. 2 is used where the accumulation is of a consistency too thick to be evacuated through the trocar, and will have the effect of liquefying the accumulation within a week or two, when the treatment should be continued with formula No. 1.

Formula No. 1.

Iodoform	5	parts.
Ether	10	"
Guaiacol	2	"
Creosote	2	"
Sterile olive oil	100	"

Of this from ten to twenty cc. are injected into tuberculous joints or tuberculous abscess cavities after the fluid has been evacuated. This is repeated once a week at first and less frequently later.

Formula No. 2.

Camphor	2	parts.
Thymol	1	"

Of this solution five cc. are injected once a week until the accumulation in the joint becomes liquid.

Beck's bismuth paste. In all cases in which operations are followed by the persistence of sinuses Beck's bismuth paste, consisting of one part of arsenic-free subnitrate of bismuth in two parts of sterile yellow vaseline, should be injected and the external wound closed with a gauze plug. We have heated the paste to one hundred and ten degrees F., and thought that this facilitated the thorough distribution of the substance to all parts of the sinuses, but others have applied it cold with apparently excellent results.

Care should be taken to inject just enough to fill all parts of the sinuses, but not enough to cause a rupture of any of the canals.

The injection should be made daily at first and less frequently later. In case of large cavities it is best not to fill the entire cavity at first until the patient's tolerance has been established. In case of poisoning the patient's gums will become sore and later a black line will develop. The patient will feel depressed. He may or may not have an elevation of temperature.

In these cases the sinuses or cavities should be filled with olive oil heated to one hundred and ten degrees F., and drainage tubes should be inserted for the free evacuation of the paste diluted with the hot oil. This should be repeated daily until the patient's condition has improved.

With fair caution, there is little danger from poisoning, but the possibility should always be remembered.

Beck's paste is one of the most valuable remedies ever introduced into the treatment of tubercular sinuses, and the results obtainable by its careful use are most satisfactory.

When used in large cavities, such as the pleural cavities, the paste should contain a smaller proportion of bismuth subnitrate. In cavities of a moderate size, we use one part of bismuth with five parts of yellow vaseline, while in very large cavities we use one part of bismuth to ten parts of vaseline. We have used this remedy in the treatment of sinuses and abscess cavities in practically every part of the body. In sinuses that are left after stomach or intestinal operations, the remedy has been especially satisfactory. In these cases, however, it is important to bear in mind that there is a slighter degree of resistance in the walls of the sinuses and abscesses than in the walls of sinuses leading down to bony structures, and for that reason it is important to reduce the amount of pressure employed to a minimum.

Dr. G. O. Switzer, of Ludington, Michigan, reports an exceedingly interesting case of suppurative pericarditis in which after drainage a sinus remained which failed to heal under ordinary care, but which healed rapidly upon the injection of the cavity with bismuth paste. We have never had an opportunity to use Beck's bismuth paste in a similar case, but, judging from the progress this patient made and from our experience in the use of the remedy in sinuses in all other parts of the body, we should certainly make use of it in event of a similar case.

In old sinuses following operation for empyema we have used the remedy many times with excellent results.

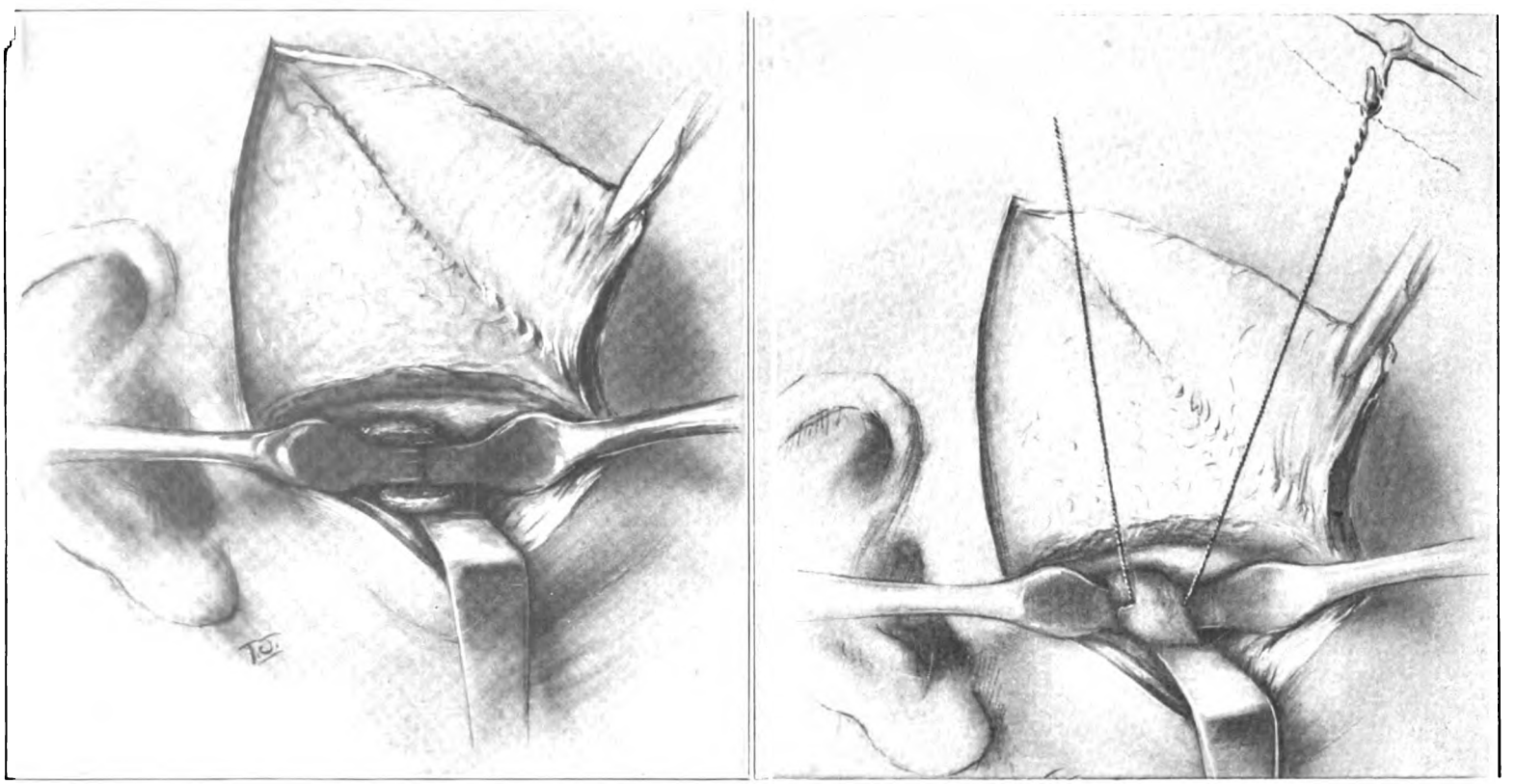
The following rules should be observed in the use of Beck's bismuth paste:

1st. Care should be taken to use subnitrate of bismuth which is entirely free of arsenic and other impurities.

2nd. It should be thoroughly mixed with the vaseline immediately before using, in order that the heavy bismuth may not settle down to the bottom of the jar and be injected in too marked a concentration, the contents of the upper portion of the jar containing little or no bismuth.

3rd. A good glass syringe should be used that will deliver a definite amount of the mixture, so that it will be possible to determine the amount used.

4th. The mixture should be injected very slowly, but continuously, in



A. B.

ARTHROPLASTY FOR INTRA-ARTICULAR ANKYLOSIS OF TEMPRO-MANDIBULAR ARTICULATION.

(From Dr. John B. Murphy, *Journal A. M. A.*, June 6, 1914.)

These figures illustrate admirably the principles involved in the brilliant operations Murphy has introduced for the restoration of ankylosed joints. Fig. a. shows the exposure of the joint by means of an L-shaped incision whose perpendicular extends upwards from the upper edge of the zygoma for a distance of 3 or 4 cm., about 1 cm. in front of the external ear. The horizontal portion extends forward from the lower end of the vertical portion for a distance of 2 cm. The soft tissues are then carefully retracted, as shown in fig. a., to expose the ankylosis, which is then cut with a Gigli saw, as shown in fig. b., or it may be severed by means of a thin chisel, great care being taken not to injure the brain, because this is separated

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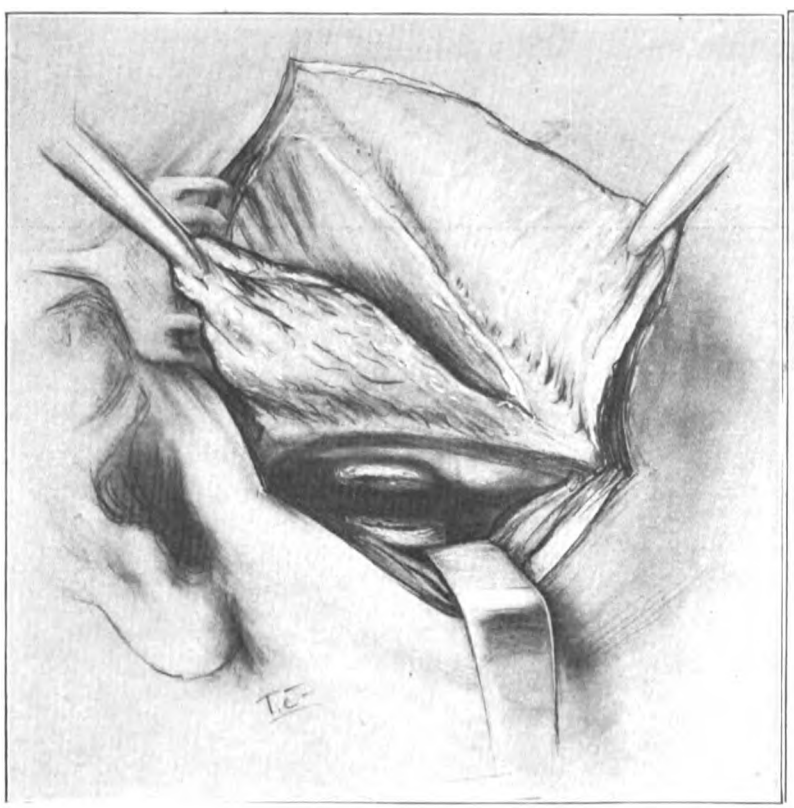

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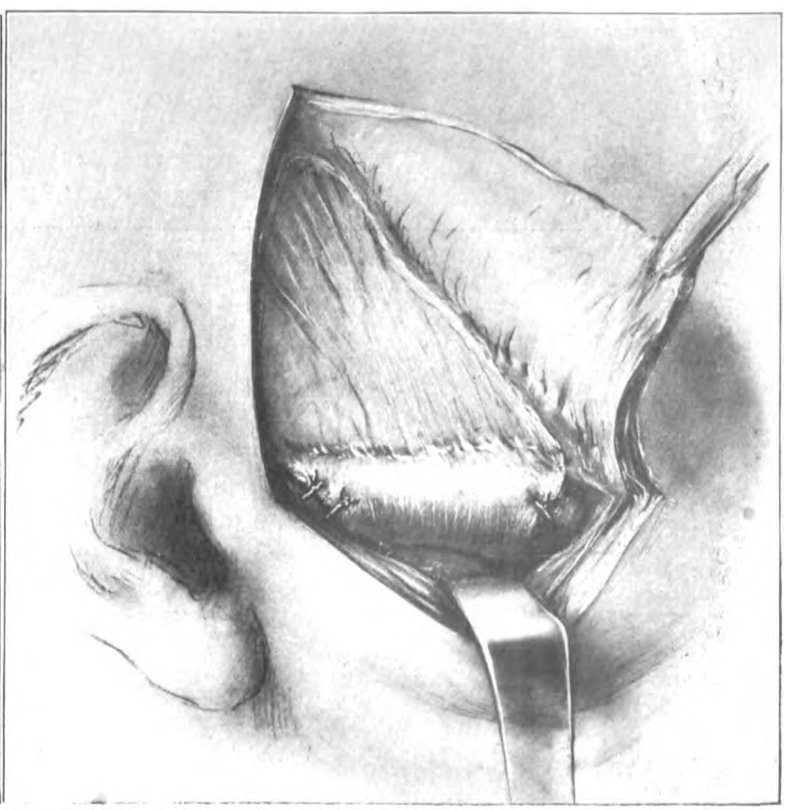


D.

by only a very thin plate of bone. It is well to use the special instruments described by Murphy for exposing the joint and for protecting the surrounding tissues, as shown in figs. a. and b. A piece of bone 1 cm. in length is removed, together with its periosteum, so that the jaw can be moved freely by the anesthetist while the surgeon's finger palpates the cut surface, to insure the fact that a sufficient amount has been removed for the placing of the interposing fat and fascia flap, which is prepared as shown in fig. c. It should be 2 cm. wide and nearly 4 cm. long, and should remain attached to the upper margin of the zygoma. This flap is then packed into the space from which the bone has been removed and securely sutured by means of cat-gut sutures, as shown in fig. d., and the skin wound closed.

order to permit the filling of all lateral sinuses and irregularities connected with the sinus through which the mass is injected.

5th. If there are several external openings, the paste should be injected through one of these, and as soon as it appears at one of the other openings, this should be closed and the injection should be continued until it appears at the next one, when this also should be closed with the finger, and so on, until the paste has successively appeared at all of the openings, which will indicate that it has penetrated all of the bifurcations.

6th. The injection should be made at first every two or three days, then, as the discharge decreases, once a week. Later, once in two weeks, then in three, and then in four weeks, but always with the same care in application.

We have applied this method in hundreds of cases and consider it one of the best aids that we have in surgery, but the work must be done by the surgeon himself, or by an experienced assistant, because it must be applied exactly right in order to accomplish the desired end.

ARTHROPLASTY

The mobilization of ankylosed joints has become a well-established surgical procedure. The principle of the operation consists in loosening the ankylosed bones or other structures interfering with motion in the joint, removing any bony or connective tissue which might later interfere with free motion, and then placing some soft structures over the denuded joint or bony surfaces to prevent a recurrence of a fibrous or bony ankylosis. In the various experiments and operations covering a period of many years the interposition of animal membrane, such as pig's bladder, and the employment of plates of celluloid, silver, rubber, magnesium foil, etc., has been followed by varying results; the best, however, are obtained by the interposition of soft tissue, such as fascia, fat and muscle. Murphy has popularized the operation of arthroplasty in America, as Lexer has in Germany. Murphy interposed between joint surfaces a pedicle flap of fat and fascia, while Lexer interposes a free flap of fat; and both with apparently equally good results.

Indications and prospects. The operation of arthroplasty is indicated in partial or complete ankylosis of the hip-, elbow-, shoulder- and knee-joints, in cases where the disability is great enough to incapacitate the patients from performing their regular duties. Our best results have been obtained in arthroplasties of the hip-joint, next the elbow-, then the shoulder- and last the knee-joint. Good results in the knee-joint are the most difficult to obtain, because in order to be movable and give ample support, it has to be mechanically very perfect.

In arthroplasties for ankylosis following fractures, especially those of the elbow-joint, the operation is often difficult because of the disturbed joint relations and the often excessive callus formation about the joint.

In cases of ankylosis following the various forms of arthritis one must not attempt an arthroplasty until it is evident that the joint has been free from all infection for a considerable time.

Technique. It is important that the most rigid asepsis be carried out to insure primary wound healing which is so essential for success in the operation. The joint surfaces are chiseled apart as nearly as possible in the place of the articulation, and bony prominences which might interfere with movements of the joint are chiseled away. The synovial membrane is now removed and together with it any connective tissue which might have a tendency to lessen motion. The ends of the bones are then shaped by means of chisel or saw, to correspond as nearly as possible to the normal contour of the joint surfaces. A flap of the muscular aponeurosis, together with a considerable amount of fat is dissected free, except its pedicle near the joint, and this is interposed between

the new joint surfaces, and fastened in position by a few catgut sutures. The joint should be immobilized for a period of two weeks. At the end of this time passive motion should be instituted and continued until there is free active motion.

THE TREATMENT OF CRUSHING INJURIES OF THE EXTREMITIES

In the treatment of crushing injuries and lacerated wounds of the extremities, the point of first importance lies in securing, as nearly as possible, aseptic conditions.

It is interesting to observe the marked difference in the difficulty one experiences in obtaining such a result in different classes of patients. For persons who are strong and healthy, who live in hygienic surroundings and are cleanly in their habits, it is relatively easy to secure an aseptic wound after one of these injuries. This is ordinarily the condition of railroad employes, skilled mechanics in factories, men employed in the iron mines in the northern part of this country, and in farmers; but not that of the shiftless who are injured in the streets. Persons who have been employed about horses are more likely to suffer from tetanus than others. This is also true of those who have been injured upon the highways.

The fact that mechanics are likely to have their hands covered with oil and particles of iron and other metal does not indicate that it will be difficult to secure aseptic conditions, as this form of dirt is usually very clean from a surgical standpoint. The oil contained in this dirt has in itself an inhibitory effect upon the development of micro-organisms.

If the injury be severe, it is usually best to anesthetize the patient, because this will enable the surgeon to be more thorough in cleansing the wound. If it is necessary to transport the patient some distance to his home or to a hospital, before it is possible to proceed with the cleansing of the wound, it is best to apply about the extremity some dry sterile gauze held in place by a compression bandage.

Control of hemorrhage. If the vessel can be caught with hemostatic forceps and ligated, such method is most convenient. If this is not possible a suture may be passed around the bleeding point, and the same ligated. If there is simply oozing from a large surface, this may be controlled by pressure, by applying a gauze tampon, to be held in place by a roller bandage.

In some instances, it is best simply to keep the extremity in an elevated position until an elastic constrictor can be applied, and the wound disinfected and the vessel ligated.

If the palmar arch has been injured, and the hemorrhage cannot be controlled by the application of ligatures or hemostatic forceps, the arm may be elevated permanently for several days by applying rubber adhesive straps to the forearm, attaching these to a cross-piece, and to this a cord, which passes over a pulley suspended to the ceiling, or upon a frame to a weight, which will keep the extremity elevated comfortably. An elastic constrictor should never be kept in position for any lengthened period. It is not safe for more than two or three hours at a time, and even this may give rise to gangrene in some cases, especially if the patient be advanced in age and suffering from endarteritis.

Disinfection. Usually the disinfection may be thoroughly accomplished in less than half an hour.

If the extremity is covered with black, oily dirt, common in mechanics, it it best to first wash with kerosene or turpentine or gasoline to remove all the oil and grease. All the particles of dirt visible should be removed by the use of tissue forceps and the scalpel, and then the wound is thoroughly soaked with iodine.

If the wound has been covered with street dust, or the patient has worked among horses, it seems best after applying strong compound tincture of iodine to the entire surface, to rub iodoform over the whole part, because it is claimed that this treatment will prevent infection with the tetanus bacillus, and our own observations appear to confirm this theory. This class of patients should also be given 10 cc. of anti-tetanus serum daily for three days as a further prophylaxis against the development of tetanus.

If a hand or finger, or any other part of an extremity, has been entirely crushed off, the remaining stump may be trimmed up at once, care being taken to sacrifice as little tissue as possible; but in the vast majority of crushing injuries it is much better for the patient if only the complete disinfection is accomplished at once, and the wound left wide open, so that the tissues may have free drainage; this will aid in preventing infection, and will favor the recovery of tissues which seem hopelessly damaged at the time of the injury or first examination. Leaving the wound without suturing until the tissues have recovered, also favors return circulation, because none of the vessels will then be constricted by stitches. Many times a very useful skin flap will become gangrenous because of the venous stasis resulting from the application of sutures directly after an injury has occurred, and before the circulation has become re-established.

For the reasons mentioned, primary amputation after crushing injuries are but rarely indicated.

It would, however, be eminently unsafe to leave these crushed tissues attached to an extremity if the surgeon were careless in his disinfection, but if he is thorough it will result in great benefit to the patient. If, however, the crushed tissue is septic when the patient comes under the surgeon's care, the conditions are entirely changed, for then not only the crushed portion may be lost, but the infection may result in a pyemia and the patient's life endangered. Here the plan of treatment should be followed that was described in connection with septic infections of the extremities. After the infection has subsided, an operation may be performed, which will be indicated by the condition of the tissues. Any necrotic portions will have been removed from time to time while the treatment has caused the septic infection to subside.

If, however, the patient comes under the surgeon's care reasonably early, the danger of a serious infection is very slight, provided the wound be thoroughly disinfected and left wide open, as mentioned above, so that drainage will be good, and the return circulation favored by elevating the extremity, and complete rest of the extremity is enforced, so that any unavoidable slight infection will not be pumped through the lymphatics in a proximal direction.

In case any pockets of local infection have been formed, these should be laid wide open, the incision in each case being carried parallel with, and not through, the important anatomical structures in the part involved.

If there are any projecting shreds of tissue that cannot possibly be utilized at any future time, these should be cut away, but no tissue, no matter how irregular, which might be used in a plastic way should be sacrificed until it is known just how much may be saved.

Too much stress has been laid upon the importance of the destruction of large arteries or veins in cases where it seemed wise to amputate at once, under the impression that gangrene would certainly occur from the destruction of important vessels. There are many instances in which anomalies have existed, which could not be determined at the time of the injury, or in which there has been an unexpected degree of compensatory circulation, so that an extremity which was theoretically doomed could be saved entirely, or to a great extent. It should, however, be remembered that one may take these chances only when it is possible to so thoroughly disinfect these wounds that we need not fear a dangerous infection by a waiting, conservative plan of treatment.

If we are not competent to secure this condition, then we must abide by the rules laid down at a time when all were equally handicapped.

In case a joint of considerable size has been opened, the course of treatment to be followed will depend largely upon the judgment of the surgeon. If it seems likely from the conditions present that an infection has taken place, it will be safest to lay the joint widely open, being careful, however, not to increase the infection, and to disinfect it in the same thorough manner as the other tissues. If it seems fairly certain that no infection has taken place, then it will be best to disinfect the wound in the joint as described above, and then to close the latter with a few catgut sutures and leave the remaining wound wide open. Too much importance cannot be given the fact that it is an easy matter to infect an open joint, and that consequently it should receive the first attention, and should then be guarded carefully until the remaining portions of the wound have been thoroughly asepticized.

What has been said of the larger joints is true of the metatarsal and phalangeal joints, but it is much less difficult to disinfect these, and consequently there is less danger to the patient.

CRUSHING INJURIES TO BONES

The large bones have been considered in speaking of compound fractures, and the same principles should be carried out in the treatment of crushing injuries of the smaller bones; fragments which are entirely loose should be removed, and irregular ends should be trimmed with bone-cutting forceps. Rough ends of bones into which dirt has been ground so thoroughly that it cannot be removed should be trimmed in the same manner.

Dressing. If it is convenient, the following dressing should be employed in wounds of the extremities. A saturated solution of boric acid in hot water, to which one-third, by volume, of strong commercial alcohol has been added, should be used to moisten the aseptic gauze which is applied directly to the wound. If there is any reason for fearing tetanus infection, a few layers nearest the wound should be composed of iodoform gauze. Over this a thick layer of cotton is applied, and over all a soft roller bandage. If there is an increase in temperature the entire dressing should be surrounded by a rubber sheet, and from a pint to a quart of the above named solution poured into the dressing every three to six hours. The quantity should be regulated by the size of the dressing, and the rapidity with which the moisture disappears.

If it is not possible to apply a moist dressing the surface should be lightly powdered with iodoform. It should then be covered with iodoform gauze, then with sterile gauze, then with cotton.

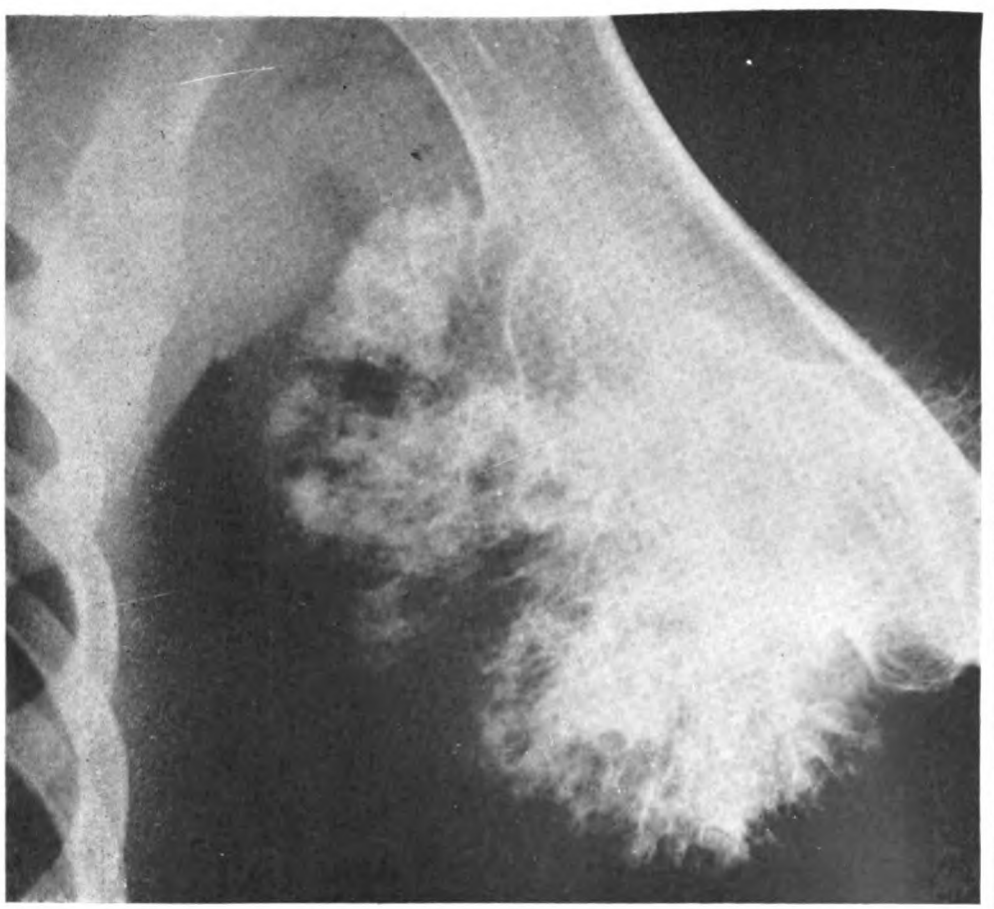
The dressings should be applied in such manner that they may be opened without causing unnecessary pain to the patient, so that the wound may be inspected regularly.

If there is a tendency to the occurrence of necrosis the wound should be inspected every day, but if at the first dressing it appears that the nutrition is good, then it will be best to disturb it as seldom as possible until it seems to have recovered sufficiently to make the operation for final repair of the injury proper. The condition of the tissues will determine this. If there are small points of necrosed tissue, it is usually best to wait until the circulation in the adjoining structures has been improved to such an extent that no further necrosis need be feared. If the tissues are trimmed too early, one is likely to remove portions that might be utilized to advantage in repairing defects.

The final technique. In making the final operation, it is far more important that the ultimate result be satisfactory than that the appearance at the conclusion of the operation be pleasing.

CASE OF MULTIPLE TUMORS OF THE BONES.

Right and left knees. This is one of a set of stereoscopic pictures. Note the symmetrical spines and "mushroom" bony growths projecting upward from the femur and downwards from the tibia. The whole knee-joint is enlarged and deformed.



Osteoid chondroma of the middle third of right humerus.

Picture of humerus after excision of tumor.

Too often a portion of an extremity is sacrificed in order to obtain a handsome stump. The absence of skin from one-half or, in some instances, even three-fourths of the portion of the extremity involved, no longer makes an amputation imperative, because the surface can be covered with skin-grafts, and if this is done before the wound has existed long enough to produce a great amount of cicatricial tissue the extremity frequently becomes very useful. The fact that nerves have been destroyed for a distance not to exceed ten or twelve centimeters does not make an amputation imperative. Neither is this the case if tendons to the same length have been destroyed, because these structures may be grafted, and although this is not always successful it so frequently results in a satisfactory functional result that it is quite worth while to make the attempt.

In covering large surfaces with skin-grafts, the method which has been described should be carefully followed, for it will result in a substantial, pliable, soft and durable covering, instead of the thin, shiny, adherent skin one encounters so frequently in cases that have been grafted by different methods.

The old rule of preserving the head of the metatarsal bone invariably, if at all possible, and the head of the metacarpal bone in men who work with their hands, should be borne in mind. It is wise to do this even if there is not sufficient skin to cover the bone. This precaution adds greatly in preserving the usefulness of the hand or foot.

A very small portion of a hand or wrist is valuable to the patient, and every effort should be used to preserve as much as possible of the upper extremity.

In the lower extremity this is also true, unless the ankle-joint is involved in the injury and the entire foot destroyed. In such case an amputation through the lower third of the leg will enable the patient to obtain an artificial limb, with which he can walk comfortably and gracefully.

Above this point it is again necessary to save as much of the extremity as possible.

NON-MALIGNANT TUMORS OF THE BONE AND CARTILAGE

Osteomata and enchondromata occur most frequently from the epiphyseal lines of the long bones but they may arise from any point on the surface of bones.

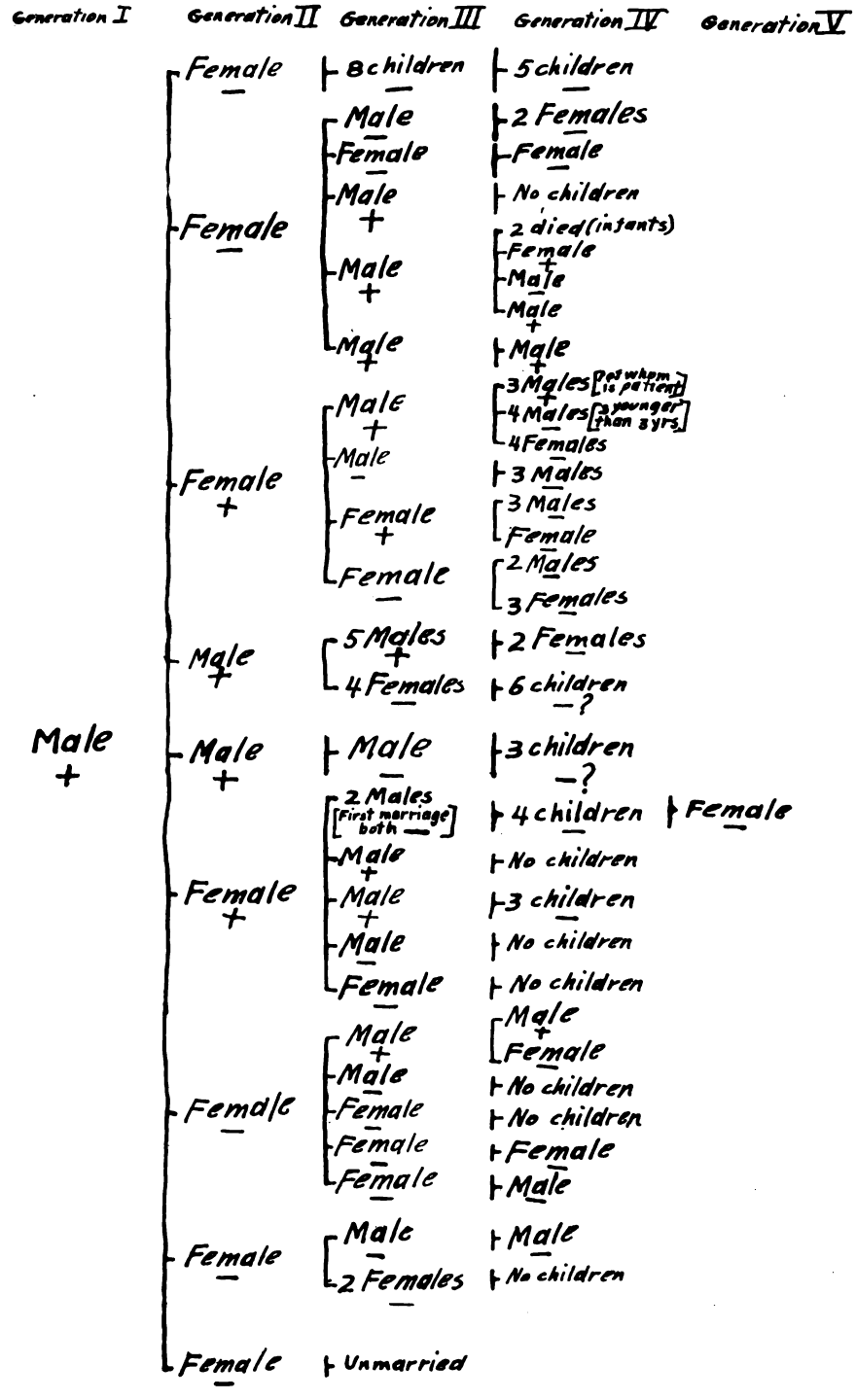
In most cases a history of heredity can be traced, except in those giving a history of traumatism. In many cases both a hereditary tendency and traumatism can be established.

These facts have long been known to breeders of horses, who have found it necessary to discard stallions having exostoses and other abnormal bony or cartilaginous developments.

Ordinarily it is not important to remove these growths because they usually develop slowly and do not degenerate into a malignant process. In case they interfere with motion or give rise to pain by pressing upon some nerve, or give rise to an unsightly deformity, they should be removed. They rarely recur and the only precaution necessary in their removal is to limit injury to any of the important structures in the surrounding areas. Frequently the nerves and blood vessels overlying the growth are much distorted, making it necessary to be exceedingly careful in exposing the growth, which should then be severed from its attachment by means of a sharp chisel.

The following case illustrates one type of non-malignant bone tumor very perfectly:

FAMILY TREE-MULTIPLE BONE TUMORS



PLUS (+) INDICATES THAT BONE TUMORS WERE PRESENT. MINUS (—) MEANS THAT NO BONE TUMORS HAD EVER BEEN DISCOVERED.

The patient is a farmer, seventeen years of age, giving a most interesting family history which will be discussed later.

Past history. The boy was a normal delivery and has always been well except for an attack of measles when a baby. When about four years of age his parents noticed a small lump attached to the outer aspect of his left ankle and apparently attached to the bone. This tumor gradually increased in size until he was eight years old, when it had reached the size of half of a small orange. The tumor later decreased in size until at the age of thirteen years it was not noticeable except for somewhat greater contour of that ankle. There was neither pain nor impairment of motion at any time from the presence of the mass. He has never had any severe injuries.

Present history. When the patient was about ten years old there was first noticed a small, hard lump on the inner aspect of the middle of the right arm as large as a hen's egg. Until the age of fourteen years, the father thinks, there was no increase in size of this lump. During the past three years, however, the tumor has steadily grown in size until at present it is about as large as a cocoanut and causes his arm to hang about 45° from the axillary line. He has no pain or discomfort of any kind except that the fingers and forearm become cold easily when he allows the arm to hang down, especially when the tumor presses against his chest wall. He has free use of all his joints and otherwise is perfectly well and strong. Neither he nor his father have ever noticed any other tumors on his body.

Physical examination. A well-developed, stockily built, well-nourished boy with good color. Weight, 130 pounds.

Head and neck. Negative.

Chest. Heart and lungs negative.

Abdomen. Negative.

Genitalia. Negative.

Extremities. Right arm. There is a large, irregular, hard growth the size of a cocoanut on the inner aspect of the middle of the right arm which is immovable with respect to the humerus. The arm does not hang perpendicularly because of the position of the tumor. The brachial artery can be felt over the surface of the tumor. The upper arm is bowed outward.

Left arm. There is a small, smooth exostosis on the outer aspect of the left humerus 3 cm. below the clavicular-acromial joint.

Right leg. Four growths each the size of an egg can be felt both internal and external, above and below the knee joints of both legs, and quite symmetrical in both legs.

Left leg. There is another hard mass the size of a hen's egg on the inner aspect of the lower end of the left tibia. The bones of the fingers and toes are all short and stubby, and attached to them can be felt many small, hard nodules varying in size from 3 mm. to 1.5 cm. in diameter. The joints, especially wrists, knees and ankles, are uniformly enlarged. The boy came to the hospital because the tumor in the arm was steadily growing in size and limiting the motion.

Operative findings and procedure. An incision was made over the middle of the tumor. It was seen that the brachial artery, veins, and nerves which normally are on the inner side of the arm were all spread out over the tumor, and the biceps muscle was crowded anteriorly and the triceps posteriorly by the growth. The circumflex artery and vein and the musculospiral nerve were involved. The tumor was attached to the humerus by a pedicle 5.0 cm. long and involving about one-third of the circumference of the shaft, and it was at the junction of the pedicle and shaft that the tumor was chiseled off. The major vessels and nerves were kept aside with retractors and none of them destroyed during the operation. The muscles were allowed to come together and fill in the hollow of the bone and after placing a rubber-tube drain in the most dependent portion of the wound, the wound was closed.

Pathology *(Gross).* The tumor is hard and cauliflower-like in appearance. It measures 13.5 cm. by 12.5 cm. by 11 cm. in diameters. The surface of the whole tumor is covered with a layer of glistening cartilage 3 to 6 mm. in thickness. Beneath the cartilage is a mixture of bony and cartilaginous substance about 1 cm. thick. The remainder of the tumor consists of a framework of hard, bony material with many spaces resembling the medullary cavity of bone.

Microscopical. The outer layer is all cartilage but just internal to it are deposits of calcium in the matrix of the cartilage. Deeper in the tumor the calcium deposits take on more of the appearance of bone in the shape of lamellæ interspaced with dense cellular tissue resembling blood elements.

Pathological diagnosis. Osteoid-chondroma.

Post-operative condition. There was no impairment of function nor sensation of the right hand. During the first three days the arm was swollen to nearly twice its normal diameter. On the fifth day the rubber drain was removed and by the eighth day, when the superficial stitches were removed, the swelling had practically disappeared. When discharged, three weeks after operation, the boy had full free use of his arm and experienced no sensations except tingling in the ends of his third, fourth and fifth fingers.

It is especially interesting to study the family history of this case which is illustrated clearly by the accompanying family tree.

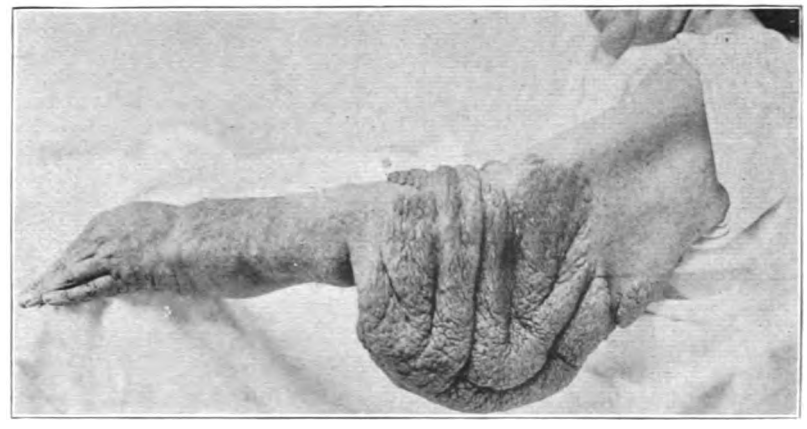
The patient is one of a family of eleven children, four females and seven males, three of whom have tumors. His two brothers and his father have practically identical tumors about

the knees. Their bones are all abnormally large. The patient's paternal grandmother and her father had like tumors. The patient's paternal great-grandfather is the first one in the family, to the knowledge of his children, who had any such tumors. He was a Hollander of short, heavy, stubby build. We were able to trace fairly accurate records of all of his children. They are shown on the chart in the order in which they were born—the first at the top—and are marked positive or negative to show whether they did or did not have bone deformities. In the whole tree there are 113 individuals. The tumors have grown in size enough to be uncomfortable in only two cases, the patient and one of his cousins, both in the fourth generation. They have never metastasized nor caused death.

SUMMARY OF CASES

Males	+ 25	= 22.1 per cent		
Females	+ 5	= 4.4 per cent		
			26.5 per cent	+
Males	— 32	= 28.3 per cent		
Females	— 51	= 45.1 per cent		
Total	113	100 per cent	73.4 per cent	—

The above table shows five times as many males as females positive, and that 26.5 per cent of the whole family are positive. The preponderance of males over females is probably accounted for by the fact that the former are much more frequently exposed to traumatism. As these tumors do not begin to be evident until the fifth or sixth year of age, and since about 12 per cent of cases are under this age, it is probable that the percentage positive will later be higher. Some of the members of the family did not know they had any of the tumors until a family physician began systematically examining everyone in his locality.



ELEPHANTIASIS OF THE ARM TREATED BY EXCISION OF THE REDUNDANT TISSUE.

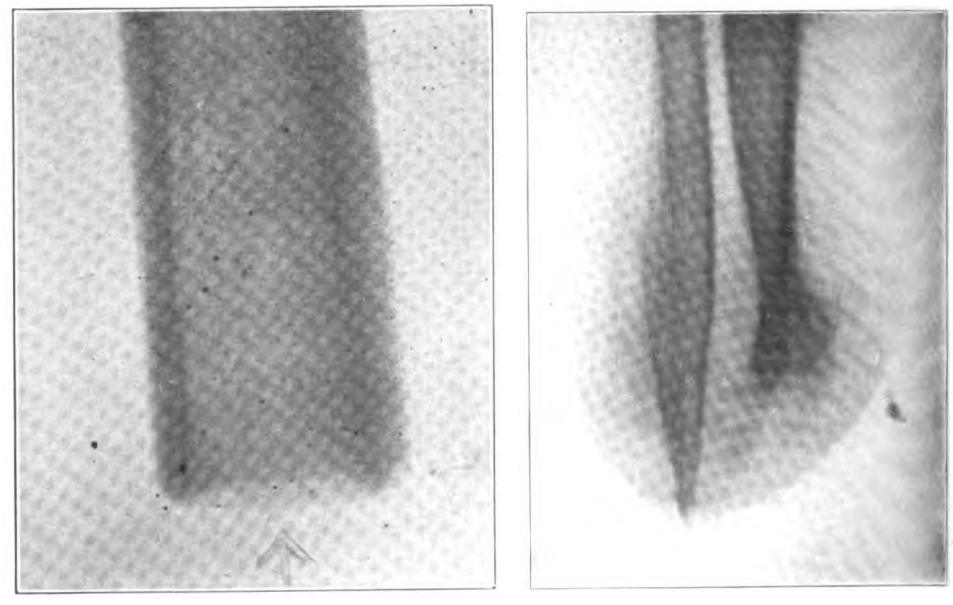
AMPUTATIONS

General rules. In making amputations, the surgeon should strive to obtain a stump in which the scar is not adherent to the end of the bone, so that subsequently there may not be produced an ulcer at the end of the stump, due to the fact that the fixed scar results in constant pressure upon a given point.

The flaps should be cut so that the scar will be exposed to as little pressure as possible. This is accomplished most readily by making the flaps of different lengths.

The sharp angles of the ends of bones should be trimmed away for the same purpose. In amputations through the long bones a circular incision should be made through the periosteum, one-half inch above the point where the bone is to be sawed off, and the periosteum should be stripped off from this portion so that the free end of the bone is without periosteal covering for a distance of one cm. The marrow of the bone should be curetted away for the same distance. This will prevent the formation of osteophytes.

If the patient be a laborer, who is compelled to walk on the soft ground or lift heavy weights, it is often desirable to obtain for him a stump which will support his body directly upon its end. This can be accomplished only by constructing a covering layer of bone for the end of the stump, effected by making the first section a sufficient distance beyond the point at which the final section is to be made, so that when the second section is made, a plate of the projecting portion can be placed across the sawed end as a covering. The flattest surface of the bone is then chosen, and a thin plate sawed upward to the point at which the ultimate section is to be made. The periosteal covering of this part is left in place, but the periosteum of the remaining portion of the bone is stripped upward and protected while this portion of the bone is being sawed off transversely.



A. B.

X-RAY PICTURES OF AMPUTATION STUMPS.

(We are indebted to Dr. H. M. Lyle, of New York. *J. A. M. A.*, Oct. 3, 1914.)

Fig. a. represents an ideal result following amputation through a long bone in which the periosteum was removed completely for a distance of 1 cm from the end of the bone, and the marrow of the bone was also curetted away for the same distance.

Fig. b. shows a very unsatisfactory end of the tibia and fibula in which exostoses have resulted from the preservation of the periosteum, the amputation having been performed in the usual manner.

The attachment of the plate which is left standing will be weakened by a few strokes of the saw, care being taken not to injure the periosteum. The remaining portion is then broken and the plate which has been thus formed is placed across the end of the bone and sutured in position by means of a few stitches of catgut passed through the periosteum.

The operation is completed in the ordinary way.

At the lower end of the femur this method can be accomplished by making a transverse section through the condyles and sawing off the lower surface of the patella.

In the upper extremity, there is, of course, never any occasion for bearing weight upon the end of the stump, hence there is no necessity for special provision against having the scar opposite the end of the stump.

For this reason the circular method has become popular for amputation of the upper extremity.

It is very important that the flaps be cut long enough to prevent tension. The larger nerves should be found, drawn down and cut off two to five centimeters from the end of the stump in order to prevent their adhesion to the scar. At the end of a nerve of considerable size, it is best to make a V-shaped section, which will permit the two ends to fall together and form a rounded point, which has a tendency to prevent the formation of an amputation neuroma.

The sutures should be drawn only tightly enough to secure coaptation.

Hemorrhage should be controlled very accurately, so that the flaps will not be separated by blood clots.

In case the wound is not perfectly dry, or if one cannot be absolutely certain that it is aseptic, drainage should be employed. This may be accomplished by the introduction of rubber drainage tubes, or by passing through the wound a number of strands of catgut or silkworm gut.

The greatest care should be exercised to prevent infection, as this favors the formation of pressure neuromata and adherent scars, both conditions being sure to cause great discomfort, if not complete disability.

The stump should be dressed with a sufficient amount of gauze and cotton to permit the application of mild, uniform pressure by means of a soft roller bandage.

Rest is one of the most important elements necessary for perfect healing, and this may be most readily attained by applying a splint in every case in which it is possible. The extremity should be elevated, in order to favor return circulation.

In many of these cases, a much better functional result may be obtained by simply trimming away the portions which cannot be utilized, after the circulation in the flaps has recovered sufficiently, and then suturing the remaining portions in the best position possible, and, later, covering the remaining surfaces with skin-grafts, than if a complete operation is performed at once. It is often possible to preserve a considerable portion of the extremity which would otherwise have been sacrificed. Many times one or two phalanges of a finger may be saved in this manner, which is a very important matter, especially to a workingman.

SENILE GANGRENE

Grades and degrees. Gangrene not directly resulting from severe traumatism or septic infection is most commonly due to a thrombosis of one or more arteries. In aged persons this is usually dependent upon arterio-sclerosis. Its immediate location is determined by an acute endarteritis which may be the result of a slight traumatism or exposure to cold, not sufficient in either case to affect blood vessels in their normal condition.

The patient feels a severe pain, usually along the course of one of the larger arteries in one of his lower extremities. Upon examination, the part of the extremity beyond the region of pain is cold to the touch. For a short time after the beginning of the difficulty the skin is white; later it becomes red, still later purple, and then black. Before it becomes black numerous belbs usually form. The area affected is at first not circumscribed, but there is a gradual departure from the normal appearance toward the proximal end of the extremity, which changes into the perfectly black at the distal end. The latter condition may extend over but a small portion of one toe, or it may include one or more of these extremities, or the entire foot, or a large portion of the leg.

Usually the morbidity progresses upwards as the thrombus increases in

extent. Many times the circulation through the smaller branches of arteries is increased because the communicating branches are dilated, and then the condition will subside and portions which have not yet become black, but which seemed to approach that state, may recover partly or completely. This tendency may be favored by keeping the extremity slightly elevated, to encourage return circulation, and by keeping the temperature as nearly normal as possible by applying artificial heat.

Treatment. In the meantime the part should be kept covered with an aseptic dressing, which will prevent infection from without. It is well to wash the skin with strong alcohol each day, when a fresh dressing is applied.

Recently the use of Dakin's antiseptic solution has received much attention. Large, moist dressings are applied as described heretofore, but enclosed in the dressing are several small rubber tubes perforated in many places, these tubes connecting with a larger tube which in turn connects with a glass chamber filled with chlorazene. This chamber is suspended above the bed and at two hour intervals sufficient warm solution is allowed to drip slowly through the perforated tubes to saturate the dressings. In our experience this treatment rapidly cleans up even severe infections, and after 24 to 36 hours a foul, moist gangrene will have no odor. The method has the further advantage of being inexpensive.

A complete description of the Carrell-Dakin method with formulae is given in the section on **Military Surgery.**

For a number of years the opinion has prevailed among surgeons that it is best to make an amputation high up on the extremity early in such an attack, in order to prevent the thrombosis from extending upward into the common iliac artery and thence to the same vessel on the opposite side. It seems that this theory cannot be supported by our own experience, and consequently we advise the plan which has been found most satisfactory in our own work. It is to be borne in mind, however, that this is an open question as yet, and that the plan here advised should consequently not be accepted as final.

Our patients have fared best when we have kept the extremity as aseptic as possible until the line of demarcation had formed. If this occurred at any point at which an amputation would result in a useful stump that point was chosen for the amputation. If a more useful stump could be secured by making the amputation higher up then that location was selected.

Amputation. It is often advisable to do these amputations under local anesthesia. When the operator infiltrates thoroughly the tissues through which he cuts, with ½ per cent. cocain or ½ per cent. novocain, little discomfort is caused the patient. Sawing the bone and stripping back the periosteum are not painful. These patients are given ¼ gr. of morphine and $\frac{1}{100}$ gr. atropine by hypodermic one-half hour before the operation. This lessens their discomfort markedly.

In making the amputation three requirements are observed:

1. The extremity is elevated in order to make the field of operation bloodless by the aid of gravitation. It is kept in this position throughout the operation, no constrictor of any kind being employed.
2. The flaps are made ample, so that they cover the end of the stump without the slightest amount of stretching.
3. No sutures are employed for closing the wound, the flaps being simply placed in apposition and a large, rather loose dressing applied to hold them in place.

The extremity is then placed in a slightly elevated position to favor return circulation. It will be seen that these precautions are intended to prevent impairment of the circulation, which is already greatly hampered.

By following these precautions the results have been very satisfactory.

After the circulation has become thoroughly established in the flaps it is safe to apply secondary sutures at any point at which satisfactory union has not taken place, or where the coaptation of the skin has not been effected.

It is important that the patient be guarded against exposing himself in the future to the circumstances which acted as exciting causes of the difficulty. He should avoid traumatism, cold and infection. His general hygienic conditions should be improved and his diet regulated.

Point of amputation in cases of gangrene. In determining the point at which amputation should be made in non-diabetic patients it is important to determine if possible the exact point to which the collateral circulation can be depended upon.

In order to determine this the sign of Moskowicz seems to be the most dependable. The following plan is simple, safe, and easily employed under all conditions.

Apply a rubber band at least 5 cm. wide around the root of both extremities simultaneously, after both have been emptied of blood by elevation into a vertical position for ten minutes. A constrictor from a blood-pressure apparatus serves admirably for this purpose. The constrictor should be applied sufficiently tight to completely obstruct the arterial circulation, but not so as to cause injury from pressure. It should be left in position five to six minutes then it should be released rapidly and simultaneously and both extremities should be placed in the horizontal position side by side in a good light so that the change of color can be accurately observed. The line of amputation should be chosen just above the line at which the color in the diseased extremity ceases to have the normal pink appearance of the entire extremity, because beyond this line the collateral circulation is defective, and if an amputation were performed through the tissues distal to this line, gangrene of the flaps would be inevitable.

Usually in the lower extremity this line passes around the limb in an irregular form because of the arterial distribution, but it is important that no part of the flap extend below the most proximal portion of the line. It may often be possible to increase the length of the stump considerably by forming the flaps in a manner suggested by this line.

DIABETIC GANGRENE

It has been observed that an operation upon a patient suffering from diabetic gangrene, is likely to be followed by death within a very few days, in fact, usually within two days, with the symptoms of diabetic coma. This fact has induced many surgeons to absolutely advise against surgical intervention in cases of gangrene complicated by diabetes. This course will disable the patient for a long period of time, if not permanently, and it exposes him to the danger of an intercurrent septic infection, which is very likely to occur sooner or later, because the tissues in diabetic patients seem especially well suited as culture media for pathogenic micro-organisms.

But in a large proportion of these cases it is not necessary to follow this plan of denial of surgical relief, for with proper precautionary treatment, it is possible to improve the condition to such an extent that they will bear amputations almost as well as patients suffering from uncomplicated senile gangrene.

The important features of such preparatory treatment consist in giving large quantities of distilled water, from two to six quarts per day, until the thirst has entirely disappeared, which is usually accomplished within two weeks, and after this the quantity of distilled water is regulated by the patient's desire. A moderate anti-diabetic diet is given—a diet which should be free from sugar, poor in starches, but in which vegetables may be eaten

very freely. The diet should further contain considerable fat, especially olive oil, if it is agreeable to the patient. In order to determine the extent of improvement in the patient's condition, it is, of course, necessary to make a quantitative analysis of the urine from time to time. In severe cases the diet should consist for the first week of one raw egg and one ounce of pure olive oil at 8 a. m., 12 m. and 4 and 8 p. m. exclusively, except in cases of severe acidosis. In these cases we give ½ oz. of pure olive oil at 8, 12, 4 and 8, and one teaspoonful of whiskey in ½ pint of distilled water at 6 and 10 a. m. and at 2, 6 and 10 p. m.

When the patient's physical state has improved satisfactorily, the amputation should be made precisely as in senile gangrene, but the greatest speed should be exercised and the slightest possible amount of traumatism inflicted. There seems to be no small danger from the late effects of anesthetics in these cases, and consequently the time of anesthesia should be reduced as much as is compatible with careful surgical work. Here also the use of local anesthesia is often advisable.

The same precautions in after-treatment should be employed as following the operation for senile gangrene, but especial attention should be given to the diet of these patients throughout the remainder of their lives.

INGROWN TOE-NAIL

The suffering brought about by this condition is very considerable and out of proportion to the simple character of the lesion. It is usually the result of tight shoes and the trimming of the toe-nail too close at the corners. When the first pain is felt an attempt is made to cut away the edge of the nail to prevent pressure. Each time the nail is usually cut a little farther back and the condition gradually grows worse. The nail of the great toe should always be cut straight across.

In the very mild cases relief may be obtained by always cutting the nail square across and wearing properly fitted shoes.

Operative treatment. In some of the very pronounced cases where both edges of the nail are involved, it may be wise to remove the entire toe-nail. In the majority, however, it is only necessary to remove about one-fourth of the nail. This can easily be done under local anesthesia.

Technique. A small rubber drainage tube used as a constrictor is placed around the base of the great toe. A solution of 1 to 1000 cocaine is now injected subcutaneously at the base and side of the nail and underneath the nail. An incision is then made down through the nail and its matrix parallel to its long axis, on a line so that about one-fourth of the nail may be removed. This one-fourth of the nail, together with its matrix and the granulation tissue along the edge, is carefully dissected away. A wedge-shaped piece of tissue is removed at the base and just below the lower end of the nail, and the defect closed with a few horse hair stitches.

A rather firm, dry, sterile dressing should be applied before the rubber tourniquet is removed.

The results from this operation are invariably good.

BUNION

Bunion is quite common but is usually looked upon as a very trivial affair, although the discomfort suffered by patients afflicted therewith is very great. The condition is usually associated with hallux valgus.

Among the various causes the wearing of pointed, short and tight shoes is the most important. Rheumatic arthritis may be a contributing cause.

Shows skin flap and bursal flap in Mayo's operation for bunion.

Shows end of metatarsal bone after its enlarged head has been removed (Mayo).

Shows bursal flap sutured into the joint cavity (Mayo).

Patients with a long great toe seem more liable to develop a condition of hallux valgus, with the formation of a bunion, than those with a short great toe.

In cases of well-marked bunion there is a true bony enlargement on the inner side of the head of the metatarsal bone of the great toe, which becomes covered with a bursal layer.

In cases where the deformity is only slight, the wearing of properly fitted shoes will often relieve them, but in the more pronounced forms an operation is the only method that affords relief.

Operation. During the past few years we have used the method of placing a flap of the bursa down over the end of the resected metatarsal bone after the method of C. H. Mayo.

A curved incision with its base downwards is made over the inner side of the metatarso-phalangeal joint and a flap of skin is dissected loose-leaving the bursa intact. A horse-shoe shaped incision is then made with its base on the phalangeal side of the joint, loosening the bursa and folding it downward, as shown. The enlarged head of the metatarsal bone is now removed by using a pair of heavy bone-cutting forceps. The accompanying illustration shows the bursal flap folded downwards and the metatarsal bone after its enlarged head has been removed. The bursal flap is now turned into the joint area in front of the cut end of the bone and held in place by a couple of catgut stitches as shown in the figure. A small puncture is made in the base of the skin flap for drainage and then the skin is closed by horsehair stitches.

In applying the dressing a folded piece of gauze should be placed between the great and second toes to overcome the valgus position of the great toe. The placing of the bursa in the joint area prevents a bony union, leaving a movable joint. The great toe is shortened and the foot somewhat narrowed at its widest line.

BLOOD TRANSFUSION

Recently because of the increased interest in the possibilities of transfusion, many methods of transfusing the blood have been devised, making the procedure practical. With the development of these various methods, the several factors responsible for the untoward symptoms following transfusion have been eliminated, and as a result, transfusion of blood in the hands of an experienced operator can be done with very little or no danger to either the donor or recipient of the blood.

Indications. Blood transfusion is used as a surgical therapeutic measure whenever all, or part, of the elements of blood tissue are needed and cannot be obtained in sufficient amounts from the hematopoietic organs of the individual. These elements may be required, (a) to replace loss of whole blood, (b) to increase coagulability, and (c) to stimulate resistance to infection and various other toxic processes.

It is a well known fact that the administration of normal salt solution or the various modifications of Ringer's solution, either intravenously or subcutaneously, has a marked beneficial effect in certain conditions where more fluid is needed that cannot be ingested by any other means. By this form of treatment, then, one can hope only to give an increased amount of body fluid. On the other hand, by transfusing whole blood, one injects a living tissue which has functions inherent on its own constituents, and which thereby serves an entirely different purpose.

When this treatment was first exploited it was used, as is usually the case, in many conditions in which it had no effect; or even did harm. At present, however, we know that in many instances the addition of fresh, living, whole

blood to a patient from another individual may save a life, cure the pathological condition present, or at least, greatly improve the patient.

The indications which, from our experience, are those best suited to this form of treatment, will now be given in more detail.

Hemorrhage. Severe hemorrhage is, of course, a specific indication for blood transfusion and it is in these cases that the most brilliant results have been experienced. In post-operative, post-partum, and gastric ulcer bleeding, this method has been advocated and used with success for a number of years. However, one should bear in mind the fact that nature attempts to control the hemorrhage in two ways: (a) by producing a fall in blood pressure and (b) by attempting to cause a clot at the end of the bleeding vessel. If additional blood be supplied in sufficient quantity to increase the blood pressure momentarily, a clot may in this way be dislodged and the hemorrhage increased. Where it is possible to check the hemorrhage by mechanical means, such as by open operation in gastric ulcer or in ectopic gestation, or by packing in post-partum bleeding, blood transfusion both before and after such procedure tides the patient over an otherwise frequently fatal period. It is in the severe hemorrhages that large amounts, from 600 cc. to 1500 cc., are given. The transfusion of amounts less than 600 cc. has not, in our experience, been sufficient to control such cases. We have also noted that amounts greater than 900 or 1000 cc. do not produce more satisfactory effects than the giving of 600 to 800 cc., and repeating one or more times. This amount seems to be best suited both to replace the lost blood and to favor clotting at the bleeding point.

Secondary anemia. In cases of persistent oozing of blood in small amounts from any part of the body, with a consequent secondary drop in the blood picture, or in which there is a constant destruction of circulatory elements from an infective or toxic process, blood transfusion has been found of great value. Amounts of 500 to 700 cc. repeated every 6 to 10 days, do as much good as when larger amounts are used. The transfusions should be repeated until the blood picture has permanently improved. Conditions included in this class are, intestinal bleeding, epistaxis, pulmonary hemorrhage, hemorrhoids, and hematuria from various causes.

Hemophilia. In this condition there is a greatly delayed coagulation time, so that small abrasions may allow of severe and persistent hemorrhage. Frequently, the blood of these patients will fail to clot in an hour or more. Here, blood transfusion may be employed during the active stage of bleeding, because enough prothrombin will in this way be supplied to produce the necessary clotting. At the same time, the lost blood is being replaced by new blood elements. For this reason whole blood is a better medium than blood serum alone. Even after the bleeding has stopped, it is wise to give occasional prophylactic transfusions of 500 to 700 cc. of whole blood in order to supply the demand for prothrombin.

Hemorrhagic diseases of the newborn. In these conditions the treatment by blood transfusion has been successful in a large number of instances, and the lives of many infants have been saved. There is, of course, great difficulty in using the veins of infants, and for this reason Helmholz has recently carried out a method which has been used in many cases. He punctures the anterior fontanelle in the mid-line and so enters the superior longitudinal sinus, which is a relatively large vessel in infants.

In **toxemia** from any cause, or where there is a condition of general debility due to disease or metabolic derangement, blood transfusion has proven of marked benefit.

Septicemia. We have seen several cases of severe septicemia following pelvic cellulitis, post-partum infection and peritonitis in which the process

had gone on to a practically hopeless stage and in which blood transfusion was resorted to as a last measure. Several of these cases were definitely improved and a few of them recovered. It would seem that in such instances the resistance of the patient was just insufficient to combat the disease. By the administration of whole blood, new antibodies and fresh red cells were furnished which became the added stimulus necessary to give the resisting process the upper hand. We therefore believe septicemia, bacteremia and toxemia to be favorable indications for blood transfusion.

Banti's disease and hemolytic icterus. These conditions are essentially surgical and blood transfusion is not indicated where the blood picture is not materially lowered. When, however, the red cell count is lower than 2,500,000, or there are persistent hemorrhages, blood transfusion should be resorted to as a preliminary treatment to splenectomy. The latter procedure offers the only hope of a permanent abatement, but the previous administration of new blood usually allows of a better surgical risk. In fact, blood transfusion has been shown by many different workers to be of benefit, at least temporarily, in practically every blood disease.

Acute surgical shock. In cases in which it is known that a severe operation is necessary, such as in carcinoma of the intestine, and in which there is a marked cachexia and general weakness, they can often be improved in a general way to such an extent that the danger of surgical shock is markedly decreased. One, two or three blood transfusions of 500 to 700 cc. given a week apart before the operation will sometimes make an otherwise hopeless condition a fairly good surgical risk. Likewise, after a long, tedious, severe operation, the administration of a pint of whole blood just after the operation is finished and while the last stitches are being applied, will make a change that is often quite remarkable. A marked improvement in the general condition of the patient is evidenced by a better surface color, a strengthening of the heart action, and a drop in the pulse rate of 30 to 50 beats per minute.

In **illuminating gas poisoning** there is a permanent destruction of the hemoglobin in the red cells as far as the oxygen-carbondioxide carrying capacity is concerned. In such cases the transfusion of whole blood, thus adding enormous numbers of red cells and fresh hemoglobin, has in several instances saved the lives of individuals that would otherwise probably have gone on to a fatal termination.

Pernicious anemia. The employment of blood transfusion will result in marked temporary improvement in the vast majority of cases. Our experience has been that, while the blood picture will improve immediately in practically every case, and that in some early cases a very prompt and marked remission will take place and may persist for a period of several months; on the other hand, in the late cases, the improvement in the blood picture from the transfusion alone is very transitory, as the blood will begin to decline within a period of two to three weeks, unless transfusion is repeated.

The immediate effects of transfusion are usually quite striking. The red blood count is increased (often doubling immediately when the count is very low), the hemoglobin percentage rises, and the number of platelets is increased. The blast cells usually become more numerous, and occasionally Howell's particles will appear in the blood, thus indicating a stimulation of the bone-marrow.

In patients suffering from pernicious anemia, in which there is no evidence of involvement of the central nervous system, the best results seem to be obtained by giving a series of blood transfusions as a preliminary measure to splenectomy.

After transfusion the patients immediately, as a rule, volunteer the infor-

mation that they feel stimulated and much "stronger than they felt before." A few hours later they become ravenously hungry, while previously food often had to be forced upon them. This hunger and relish of their food persists even after the red-blood count begins to fall, which usually takes place about ten days or two weeks later. With the improvement in the appetite the mental symptoms grow better, the insomnia is relieved, and the glossitis clears up. There is no doubt that the transfusion of large masses of whole blood accomplishes more than the mere mechanical addition of so much blood. It seems that it actually exerts either a curbing influence on the hyperactive spleen, or a stimulating action on the bone-marrow, since the blood picture continues to improve for several days after transfusion. This may be due to the fact that the blood-forming organs are not only overworked, but are also undernourished. Furthermore, multiple blood transfusions supply protective antibodies and assist the patient in getting rid of the secondary changes which have taken place in the various organs. During the period when the patient is being prepared for operation by multiple blood transfusions, he should be treated to eradicate any self-evident infection, such as infected teeth or tonsils, pyorrhea alveolaris, etc.

Preliminaries to transfusion. The most important part of transfusion is the selection of a healthy donor, and hemolytic and agglutination tests between the two bloods. In addition to this, it is well to determine as nearly as possible the exact condition of the blood before transfusion in both the donor and the recipient. This examination should consist of a red and white cell count, hemoglobin percent., coagulation time, a differential count, also noting the character of the various types of corpuscles.

Donor. In selecting a donor, it is important in addition to making hemolytic and agglutination tests, that a careful history be obtained from the donor, and a complete physical examination made, including a Wassermann test. Donors should not be chosen from persons giving a history of recent attacks of typhoid fever, pneumonia, diphtheria, tonsillitis, malaria, or influenza, or from persons suffering from tuberculosis, chronic arthritis, rheumatism, or where there is a history of hemophilia.

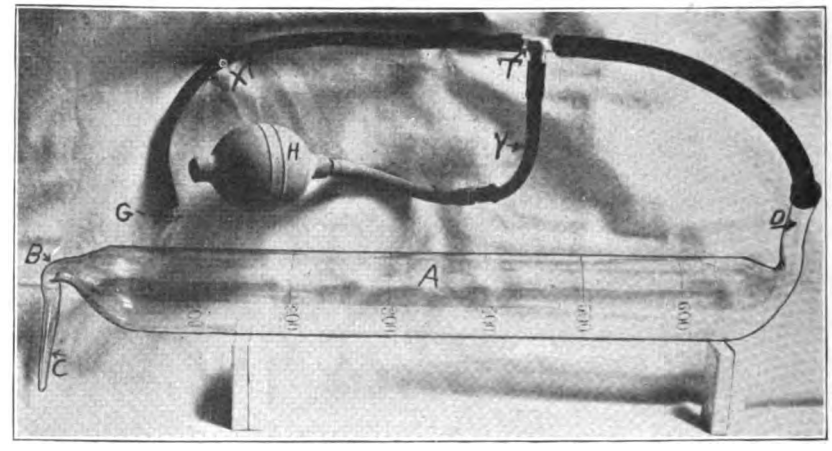
Hemolytic and agglutination tests. A hemolytic or agglutination test of each blood upon the other should always be made before transfusion, because it has been found that in a considerable per cent. of cases there is a tendency of the serum of one blood to cause a disintegration of the red cells of another, even when the latter be a near relative. While the bloods from members of the same family are more apt to be compatible with each other than aliens' blood, still it is never safe to use even a near relative as a donor without making an hemolytic test between the two bloods to be mixed.

The technique of making an hemolytic test outside the body is as follows: 10 cc. of blood is collected from the median vein of the donor (D), 5 cc. of which is placed in a dry centrifuge tube and allowed to clot, and the remaining 5 cc. mixed thoroughly with 10 cc. of one-half per cent. sodium citrate in normal salt solution. The latter solution preserves the red cells and prevents clotting. Both tubes are now rapidly centrifuged. In one tube the clotted blood will separate, leaving a clear serum as an upper layer, 1 cc. of this serum is then added to 9 cc. of normal salt solution in a test tube and labelled "10 per cent. solution of D's serum." The other centrifuge tube now contains a compact layer of red cells in the bottom and an upper clear layer of mixed serum and salt solution. This upper layer is carefully poured off and the same amount of fresh normal salt solution so added with a pipette as to mix cells. The tube is again centrifuged. This procedure is repeated ten or twelve times in order to thoroughly wash the red corpuscles free from serum

Finally, 1 cc. of the corpuscles is mixed with 9 cc. of normal salt solution in a test tube and labelled "10 per cent. suspension of D's corpuscles."

Ten cc. blood is collected in the same way from the recipient (R), and 10 per cent. solution of serum and 10 per cent. suspension of cells prepared as above and placed in separate test tubes. These four 10 per cent. solutions and suspensions are used in setting up the test.

In a clean test tube 1 cc. of D's serum is mixed with 1 cc. of D's corpuscles. In a second tube 1 cc. of R's serum is mixed with 1 cc. of R's corpuscles. These two tubes are used as controls. In a third tube 1 cc. of D's serum is mixed with 1 cc. of R's corpuscles, and in a fourth tube 1 cc. of R's serum is mixed with 1 cc. of D's corpuscles. These four tubes are placed in the incubator at 37.5° Cent. for two hours, during which time the tubes are shaken several times. They are then placed in the ice-box for twelve hours, and shaken occasionally to insure mixing. At the end of this time the reactions are ready to be noted. If the blood cells remain as a layer in the bottoms of the tubes and



TRANSFUSION APPARATUS.

The Percy transfusion tube and connections. "A" tube, "B" bend for canula "C." "D" pressure end. "T" glass tube. "H" pressure bulb. "G" mouth piece.

there is a clear, nearly colorless fluid above; or if the mixed suspension be quite cloudy and not transparent, there has been no hemolysis. If there are no red cells present as a layer, or if the shaken tube is clear, there has been hemolysis of the red cells. The two control tubes should show no hemolysis; if they do there has been an error in technique.

Agglutination test. During the past two years the authors have been determining the hemolytic action of the blood by the Moss method, the technique of which has been modified by Brem. This method is based on the principle that before the serum of one blood will cause an hemolysis of the corpuscles of another, it will first, or simultaneously, cause an agglutination of the corpuscles. The reverse, that all cases that show agglutination will also show hemolysis, is not necessarily true, only occurring in about 20 per cent. of cases. Adopting this principle, all bloods are classified according to the agglutinative properties of their elements into one of four groups. In selecting a donor, it is always advisable to have one whose blood belongs to the same group as that of the patient. If this is impossible, the donor's blood should belong to a group whose corpuscles are not agglutinated by the serum of the patient. The bloods of group IV answer this requirement for all the other groups, as its corpuscles are not agglutinated by the serum of any group. Fortunately,

group IV is the most common group, Moss having found that 43 per cent. of all individuals belong to this group.

Moss found that all bloods, whether normal or pathological, could be classified into four groups by agglutination tests of the serums against the corpuscles. He found the groups to be as follows:

Group I. 10 per cent.—Serum does not agglutinate corpuscles of any group. Corpuscles are agglutinated by serum of II, III and IV.

Group II. 40 per cent.—Serum agglutinates corpuscles of groups I and III, not IV. Corpuscles agglutinated by serum of III and IV, not I.

Group III. 7 per cent.—Serum agglutinates corpuscles of groups I and II, not IV. Corpuscles agglutinated by serum of II and IV, not I.

Group IV. 43 per cent.—Serum agglutinates corpuscles of groups I, II and III. Corpuscles are not agglutinated by any serum.

The serum of one group will not agglutinate the corpuscles of blood belonging to the same group.

Moss Chart Showing the Reaction of the Various Blood Groups Against Each Other.

	Corpuscles.			
Group I	Group II	Group III	Group IV	Serum.
0	0	0	0	Group I
+	0	+	0	Group II
+	+	0	0	Group III
+	+	+	0	Group IV

In grouping, the unknown blood should be tested with a blood whose group is known. This "standard" blood must belong to either group II or III in order to be of any value in grouping other bloods. The group to which a blood belongs becomes fixed by the third year of life, and remains constant. It is not influenced by age, disease or transfusion of blood belonging to another group.

It will be seen from the above table that the serums and corpuscles of the same groups do not in any way interact. It will also be noted that there is a wide, undetermining variety of reactions possible in the cases of groups I and IV. The reactions in the two remaining groups are more limited and definite, and for that reason, groups II or III only may be used as the standards in the Moss test.

The basis of the blood examination for transfusion is the agglutination reaction. Agglutination is considered as an early stage of hemolysis, and is always present, hemolysis never occurring without a primary agglutination of the blood cells, while, on the other hand, agglutination may occur and does

occur without hemolysis. It is from this agglutination that we arrive at our conclusions. The serum of a given blood contains a protective agent (anti-hemolysin) for its own corpuscles, this serum having a tendency to prevent hemolysis. The serum does not contain a corresponding anti-agglutinin, so hemolysis may be prevented without in any way hindering the agglutinating reaction. In the original method of Moss, two platinum loopfuls of the agglutinating serum was added to one loopful of corpuscles from the blood to be tested. By this method oftentimes the stage of agglutination was so transient that its presence was not recognized, and the agglutination went on to complete hemolysis. The correct interpretation of the test was therefore impossible, as the observer failed to recognize the determining factor—agglutination. To remedy this, Brem, besides the two loopfuls of agglutinating serum and one loopful of the corpuscles of the blood to be tested, added one loopful of the protecting serum; that is, serum of the same blood from whence the corpuscles were derived. This protective serum, as we stated above, contains anti-hemolysins, but not agglutinins. By this means the agglutination is not in any way affected, but the hemolysis of the blood cells is retarded or prevented, so giving a relatively slow, definite, easily recognizable stage of agglutination. The technique, based upon these considerations, is as follows: 10 to 20 drops of blood are collected in a small test tube from the lobe of the ear. This is allowed to clot, and then the tube is centrifuged so as to obtain a clear serum above. This is the protective serum when used with its own corpuscles, but when it is used with the corpuscles of another blood, it is called the agglutinating serum. In another small test tube are collected two drops of blood in about 1 cc. of solution composed of 1.5 cm. sodium citrate, 0.9 cm. sodium chloride in 100 cc. of distilled water. This gives approximately a 5 per cent. suspension of the corpuscles. This tube requires no further preparation.

Upon cell slides rimmed with petrolatum to prevent evaporation, are made ordinary hanging drops.

On one slide is put 2 loopfuls of standard serum (agglutinating serum) plus 1 loopful of the suspension of corpuscles of the blood to be tested, plus 1 loopful of the protecting serum; that is, the serum from the same blood as the corpuscles.

On the other slide 2 loopfuls of the unknown serum, (of the blood to be tested) plus 1 loopful of the suspension of corpuscles from the standard or known blood, plus 1 loopful of its protective serum.

It will be seen from the above table that one slide contains the standard or known serum, while the other, the standard or known corpuscles. Deductions are made, using the standard serum and corpuscles as a basis (group II or III used as the standard groups) after the agglutination is recognized.

An endeavor should always be made to have the donor and the recipient of the same groups, so reducing to a minimum the possibilities of reactions. If, in an emergency, blood must be given immediately, or if the recipient be a member of groups I or III, the rarer groups, certain deviations may be practised in which blood of unlike groups can be used. Under such conditions, the serum of the recipient must never agglutinate the corpuscles of the donor, while the serum of the latter may agglutinate the corpuscles of the patient. The serum of the donor, as it enters the blood stream of the recipient, is diluted to such an extent as to be practically inactive. The lack of agglutination of the patient's corpuscles is in part prevented by the fact that the recipient's corpuscles are protected by its own serum; i.e., the protective serum.

Except in extreme emergency cases, one is never justified in making a blood transfusion without first having made an hemolytic test between the two bloods to be mixed. Even between near relatives, such as sister to sister, or parent to child, etc., severe fatal hemolysis may occur from mixing the two bloods.

In case of a large family in which the father and mother are not in the same blood group, usually some of the children will be in the same group as the mother, and some in the father's group, and occasionally some in still another group. Thus it is plain that a brother might be a suitable donor for one brother but not for another; also he might be a suitable donor for one parent and not for the other.

Method of preparation of the transfusion tube. The tube must be dry and free from blood. After use it is washed quickly with cold water, adding lead shot and shaking, if necessary, to loosen the clots. Then wash with alcohol to free the tube of water, and finally with ether to remove the alcohol. When the ether evaporates, the tube is clean and dry. Two ounces of shredded grocer's paraffin is placed in the tube through the end "D." It is then wrapped in a towel and placed in a steam autoclave for 15 minutes at 15 pounds pressure. The tube may also be sterilized by placing it in an oven or bacteriological dry heat apparatus, raising the temperature to 165° C. for 5 minutes. A higher temperature may burn the paraffin. At the end of this time, and with sterile rubber gloves over the hands, the tube is rolled around while cooling so that every part of the inside is covered with melted paraffin and any excess allowed to run out of the large end "D." The paraffin now hardens along the inner surface in a uniform layer. Care should be used not to allow the canula to be plugged with paraffin—if it does, the tip is warmed over a flame and the paraffin allowed to run back into the tube. Sterilizing rubber tubing, glass "T," and mouth piece is done by placing them in a towel and autoclaving in the same way and at the same time as the transfusion tube, or by boiling them for 20 minutes. The atomizer bulb is thoroughly washed with alcohol to sterilize. When ready to use, the connections are all made, the rubber clamped at "Y" and opened at "X," and 2 ounces of sterile liquid paraffin aspirated into the tube through the canula by means of suction at the mouth piece "G."

Technique of transfusing the blood. The arms of both donor and recipient are prepared as for a surgical operation and constrictors placed around both just below the axillæ. Constriction by means of a rubber tube is not satisfactory, because the amount of pressure is not known, nor can the pressure be varied as desired. An ordinary blood pressure apparatus pumped up to 60 to 80 mm. of mercury, depending upon the rapidity with which the blood flows, makes an excellent constrictor. By this means the venous circulation is impeded but not the arterial, as shown by the presence of a radial pulse. It is best to use a separate set of instruments on different tables for donor and patient in order not to transmit infections from patient to donor. Under local anesthesia with one-half per cent. novocain solution intradermally, an incision is made over the basilic vein just above its junction with the median basilic, and a ligature placed about the vein in its proximal portion in the donor, and in its distal portion in the recipient. Rubber-covered, bull-dog clamps are placed on that portion of the vein away from the ligature in each patient and a longitudinal incision 3 mm. long made through all coats of each vein midway between clamp and ligature. Small retention clamps are placed on the two edges of each incision in each vein in order to hold them open. With the rubber hose of the transfusion apparatus clamped at "Y" and open at "X" the canula is placed, pointing distally, in the vein of the donor and the bull-dog clamp released from the vein. By means of suction at the mouth piece "G" venous blood is drawn into the tube up to the required amount. The blood is well protected from the sides of the glass by the paraffin coat, and from the air by the liquid paraffin that floats over and completely covers the blood. In our experience under these conditions blood has not coagulated for as long a time as thirteen minutes. The rubber hose is now clamped at "X" also and the canula removed from the vein

After removing the tube from the donor, the canula is placed in the lumen of the vein of the recipient and the bull-dog clamp, clamp "Y," and constrictor, are released. The blood will now flow into the vein of the recipient toward the heart, the velocity of which flow may be controlled by careful contractions of the rubber atomizer bulb "H." As soon as it is evident that the blood is flowing properly, an assistant may release the constrictor from the donor and ligate the vein distal to the opening from which the blood has been taken. Horsehair stitches may be placed in the skin wound, then covering the donor's arm with a small sterile dressing. Not more than four minutes should be utilized in obtaining the blood, nor five in injecting it. The length of time required to fill the tube with blood varies with different donors. It is well to have two tubes ready so that if it is found that the first tube fills slowly, taking more than four minutes' time to get the required amount, the process may be repeated with the second tube, aspirating only the remainder of the required amount of blood. Forcing the blood too rapidly may cause an acute dilatation of the right heart.

After injecting the blood into the recipient, the proximal portion of the vein is ligated with catgut and the skin sutured as in the donor. The entire procedure may be carried out every ten or twelve days, using different portions of the same vein, the corresponding vein in the other arm or different veins in the same arm. The basilic is the best to use because it is comparatively easy to find and the resulting wound is not so painful as when situated at the bend of the elbow.

Quantity of blood. In adults, 600 cc. may be injected at a time without danger. In patients, however, who have been weakened over a long period of time, it is best to give only one-half this quantity at the first time. The proportion in children varies with age similarly as the dosage of drugs varies.

Advantages of this method. 1. Known quantities of blood may be administered.

2. 600 cc. can be given in from seven to ten minutes from the time the canula is inserted into the donor.

3. Venous blood is utilized so that arteries, such as the radial, are not destroyed.

4. Transfusions may be made without contaminating the donor with the blood of the recipient.

5. No air comes in contact with the blood thus lessening the liability of clotting.

6. There is direct communication between vein and chamber by a simple paraffin-lined glass tube. There are no metal, rubber nor other connections whose edges cause resistance to the flow.

7. All of the apparatus is simple and can be made by any good glass-blower.

Reactions following transfusion. The majority of our patients have not experienced any noticeable reaction whatsoever. In about 5 per cent. of the cases a slight chill has occurred, followed by temperature, and in an additional 5 per cent. a mild temperature developed the same evening or day following the transfusion. This applies to transfusions in which the patient and donor were in the same blood group, as classified by Moss. Whenever we deviated from this and used a donor from a different blood group than that of the recipient, as was occasionally necessary, the transfusion was usually followed by a marked chill and temperature. A donor from a different group than that of the recipient was never used except when the patient was in one of the rarer groups, and it was difficult to find a donor belonging to the same group. In these instances, a donor was chosen from group IV, a group whose corpuscles would not be agglutinated by the serum of the recipient.

Factors of safety. The chief points to be borne in mind in blood transfusion are: the avoidance of hemolysis, air embolism, clot embolism, and acute dilatation of the heart.

The greatest risk from the operation is that from hemolysis. This danger can be avoided in the vast majority of cases if careful hemolytic and agglutination tests are always made preliminary to transfusion. While laboratory methods have their limitations and are not infallible, still, if the tests are always carefully made, the danger from hemolysis is slight.

The danger from air embolus and clot embolus can always be avoided if proper care is exercised in carrying out the technique of the operation.

The danger of acute dilatation of the heart is probably not as great as is generally supposed. So far, the authors have not encountered a case in which there was any evidence of the heart having been embarrassed by the transfusion. It is well, however, not to inject the blood too rapidly in very weak and anemic patients, especially if it be the first transfusion.

Summary. 1. Transfusion of blood is the most efficient means at our command for treating hemorrhage and the majority of hemorrhagic diseases, as well as many of the wasting diseases.

2. The proper selection of donors by adequate preliminary tests for compatibility is essential.

3. Amounts of from 500 to 800 cc. of whole blood, repeated at intervals of seven to fifteen days, are most desirable.

4. A simple, rapid method of transfusing should be used. This should preferably be one in which plain, whole blood is administered without mixing with any foreign substance; furthermore, the blood should not be unduly exposed to the air, and the interval that it is out of the circulation should be reduced to a minimum. An indirect, closed method by means of a prepared container seems to best answer the requirements.

PART XI

MODERN MILITARY SURGERY

INTRODUCTION*

Although military surgery is in many respects different from civil practice, there has been noted a marked tendency of some of the workers to overlook the general principles of surgery. The principles that underlie ordinary and civil surgery are identical, in the main, with those that govern the injuries due to the use of modern firearms, and a surgeon who is to serve on the battle-field needs just as sound a preparation under the guidance of a master as if he were to remain at home. In fact, the exigencies of war are such that the injured must have the best possible care in order that they may return to the front, for the most important factor of all is the winning of the war. It is only through competent, efficient and well-trained men that the surgical work of an army can be brought to the standard demanded by the conditions of war.

When the present war began there were but immature preparations made for the handling of the wounded, resulting in a high rate of mortality and of disabilities. These facts were noted at once, however, and the surgical corps of all armies immediately took steps to improve their work and the conditions under which they labored, with the result that the surgical departments of all the armies have become highly efficient.

It is our plan in this section to describe only those methods of treating the wounded which we have tried and found useful, or which, in our judgment and viewed from our former experiences, are methods that seem logical and reasonable. Naturally, there has been an enormous amount of surgical literature prompted by the conditions in Europe, and so a summary only of the most important and lasting experiences will be given.

The main surgical peculiarities of the present war are undoubtedly due to the nature of the weapons and to the conditions under which the wounds are received and in which the injured man must exist for some time after the injury. It is, then, more a question of the environment than of the nature of the wounds.

War surgery is the surgery of gunshot wounds. Such wounds are produced by bombs, hand grenades and indirect missiles, as well as injuries from projecting large and small guns. The great difference between civil and military surgery is due to the immense difference in the conditions under which the work is done. The civil surgeon operates under aseptic conditions that are practically ideal, while the military surgeon only infrequently sees a case that is not infected. The wounded man is often exhausted by the fatigue and privations of campaigning when he falls on a soil that is infected

* The authors stand indebted to Fauntleroy's *Report on the Medico-Military Aspects of the European War*, for many of the illustrations reproduced in this section in modified form.

with all of the virulent pyogenic organisms found in fecal matter and on which he is apt to lie for days before surgical aid can reach him. He is next subjected to the trying influence of long and often improvised transport, during which proper food, good nursing, rest, and favorable environment are frequently absent. Hospitals must be improvised at the beginning of the campaign and these are often overcrowded from the sudden influx of wounded following a battle. This overcrowding usually brings a scarcity of food and of surgical supplies. To add to the difficulties at hand, the wounds, which are practically all infected, are of manifold varieties, occurring in all parts of the body and involving every tissue. Military surgeons in the United States, who treated gunshot wounds on hot, dry, sterile plains, with plenty of fresh air and sunshine, were seldom troubled with the complications arising from the varied infections now shown on European battle-fields.

ILLUSTRATING MARKED MUTILATING EFFECT OF BOMB WOUND OF THE FACE.

The present method of entrenched warfare is far different from that of any previous war. Men remain for months in deep holes, often contaminated by excreta. In these underground holes and tunnels they are striken by shells, shrapnel bombs or bullets from above, or blasted from their positions by mines planted beneath the trenches. This type of warfare is the cause of a greatly increased primary mortality and of the terribly mutilated flesh and bone wounds now so frequently seen.

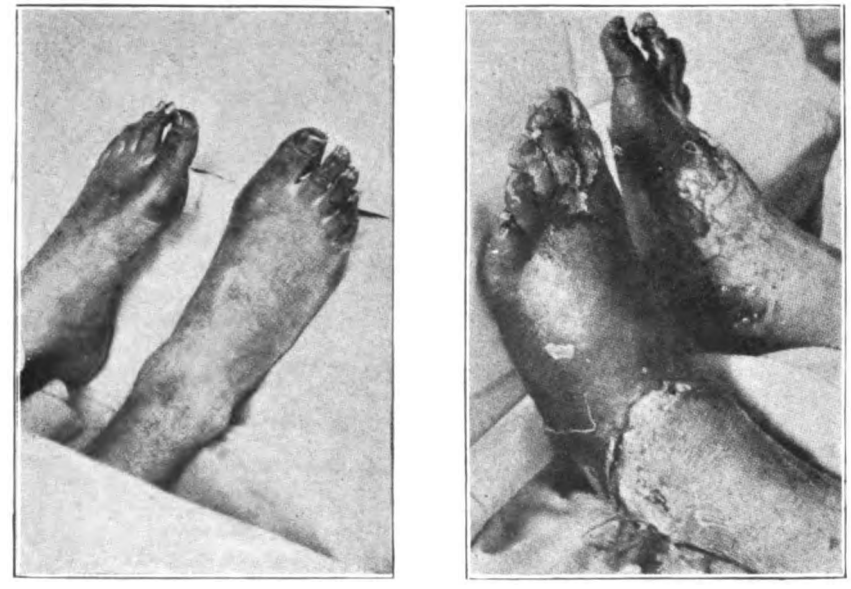
Another difference in the present effects of war is in the type of missiles used. The high velocity, pointed, but unbalanced bullet, the shrapnel with a variety of sizes and speed of its irregular missiles, and the bombs with their destructive effects, all produce wounds which have seldom been seen before the present war began.

While there has been an enormous amount of infection of wounds produced, it is a most significant and gratifying fact that no great epidemics of the plague, typhoid fever, typhus fever, tetanus, or small-pox have been extant. This is a result of the most efficient work of the sanitary corps of each army

in the field. While it is admitted that a few smaller epidemics of some of the infectious diseases, such as small-pox and measles, have broken out occasionally, these have been quickly suppressed, so that no army has suffered great loss since the deplorable typhus epidemic of Serbia in the first few months of the war. The sanitary units of each army are at present a very important, and at the same time efficient, part of the service, for army officials realize that such service has kept a greater proportion of men on the lines than in any other war.

Great strides have been made in methods of transporting the wounded from the battle-field to the dressing station or hospital. Ambulance companies are organized by the governments under which they are working or, as is usually the case, by the Red Cross Association or by private interests.

Base hospitals are now being established nearer the front than formerly, and casualty clearing stations are gradually being discontinued. For this



SHOWING DIFFERENT DEGREES OF TRENCHFOOT.

reason railroad transportation of the wounded has assumed much greater proportions. While it is true that many patients could have their wounds properly dressed, or operations performed, to better advantage if done within a very few hours, still the opinion is that hospitals of thorough enough equipment cannot be established close to the firing line. Patients can usually be admitted to base hospitals at the present time in from a few hours to two days after receiving their injuries. At such hospitals, then, primary major operations may be performed with a much more favorable environment. It is also the practice in England, France and Germany to establish specialist centers in each military zone, so that now there are hospitals for the head and neck, for the eyes, for the feet, for fractures, for nerve injuries, etc. Specialists are located at these various hospitals and the patients are evacuated to them from the base hospitals at intervals. The majority of these hospitals are located in the interior; those of the English army, in England, those of France, in the larger cities, like Paris and Lyons, and those of Germany and Austria, in the larger cities, such as Berlin and Vienna.

The lessons learned from the unprecedented use of heavy armament, of high explosive charges of terrific detonating power, of enormous numbers of machine guns and of predominant trench warfare during the European war of 1914-1917, are certain to dominate the methods of warfare for some time to come.

As a direct consequence of these modern factors, the nature and relative frequency of military wounds has been materially altered. The problems of trench fighting have become those of siege, rather than of mobile warfare, and the necessity for blasting men out of reinforced earthen entrenchments by high explosive shells has led to the natural result that wounds from artillery projectiles have become more than twice as frequent as bullet wounds; whereas in the various types of mobile warfare, artillery wounds seldom exceed from 10 to 25 per cent. of all wounds. Trench warfare has also been responsible for a sharp increase in the proportion of killed to wounded, this rising from about 1 to 5, as reported by the British in the Boer war, to about 1 to 3 for all classes of military activity, and about 1 to 2 in essential trench fighting, the greater frequency of projectile injuries to the head, due to its relatively greater exposure, and the excessive mortality of the wounds, being largely instrumental in this increase.

PROJECTILES

The general care of battle wounds presupposes a knowledge of the conditions of employment of shrapnel, shells and bullets, of the mechanism of their action, and of their characteristic effects upon living tissues.

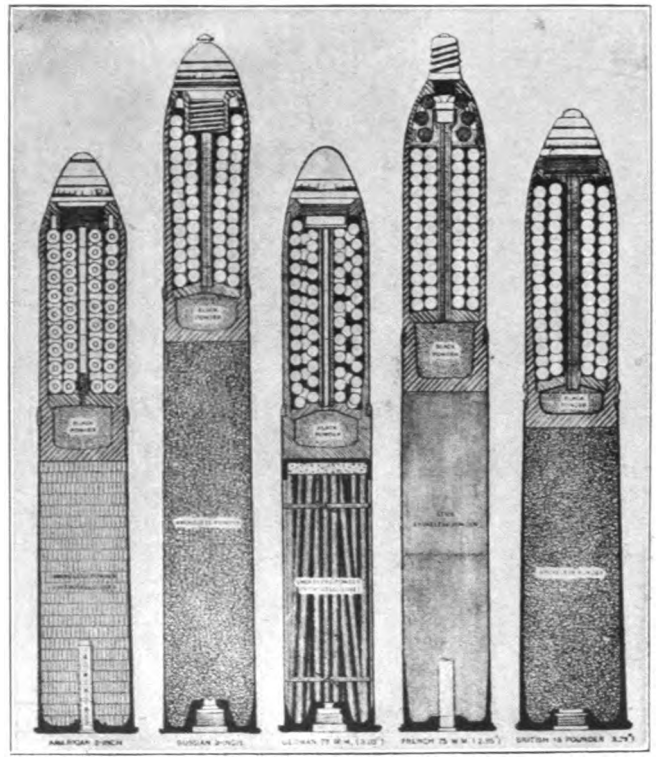
Shrapnel, which are responsible for about three-fourths of all artillery wounds in mobile warfare, consist of cylindro-conoidal casing of cupro-steel, weighing from 15 to 20 pounds, containing from 300 to 500 round lead bullets usually hardened with antimony, from 1 to 1.5 cm. in diameter and weighing from 10 to 16 grams each. These are imbedded in a smoke-producing matrix, usually a variety of sulphur, which indicates the point of explosion to the artillery observer. The base of the cylinder contains a bursting charge of some high explosive, usually of terrific detonating power, which is timed by a fuse in the detachable head, to explode at any given point in the projectile's flight, or on impact. The characteristic feature of shrapnel which determines the main use and makes it most effective against bodies of troops in the open, is the forward-reaching of the charge after bursting, the bullets being propelled forward and downwards in a cone-shaped stream, whose velocity depends upon the velocity of the shell rather than upon the power of the bursting charge.

Each shrapnel bursts into from 2 to 3000 fragments, varying in size from large irregular pieces of casing possessing all the terrible lacerating effect of solid shot, to jagged lumps of metal and fine sharp slivers. More than 70 per cent. of the ammunition used by field guns in modern battle is in the form of shrapnel and anti-aircraft guns are exclusively of this type.

The effect of shrapnel bullets is like that of the old rifle bullet, in that the power of penetration is comparatively slight. They cause local depressed fracture of the skull without laceration of the dura much more often than they perforate the dura and lodge in the brain. The characteristic tendency of a shrapnel ball is to break one bone and to lodge immediately. At first it was reported that only about 40 per cent. of all shrapnel wounds were infected, but now it is known that practically all are primarily infected. It is certain that infection is the most serious element of these wounds and often fatal. The literal covering of entrenched soldiers with mud, largely manurial in origin, is mainly responsible for this excessive infection in trench warfare.

Shells, among which are included bombs, grenades of all kinds, and, from their similarity in effect, mines, range from sizes scarcely larger than shrapnel to great cylindro-cones as tall as a man and weighing over a ton. The cavities of these iron or steel casings enclose a violent explosive charge which, in the case of bombs and hand grenades, is often partly replaced by irregular metal fragments of all kinds, as well as by corrosive fluids and irritant and poisonous gases.

A characteristic feature of the wounds is the formation of numerous "pockets," owing to the separation of muscle layers along the fascial planes, a matter of great importance if infection is allowed to gain a foothold. Surgical experience has shown that the larger and more irregular the missile, the greater the probability of infection from the larger amount of tissue torn and exposed; and as shell fragments are always rough and jagged, these wounds are nearly always found infected. Streptococci and staphylococci are invariably present, with the fecal organisms of tetanus and gas-gangrene frequently super-added.

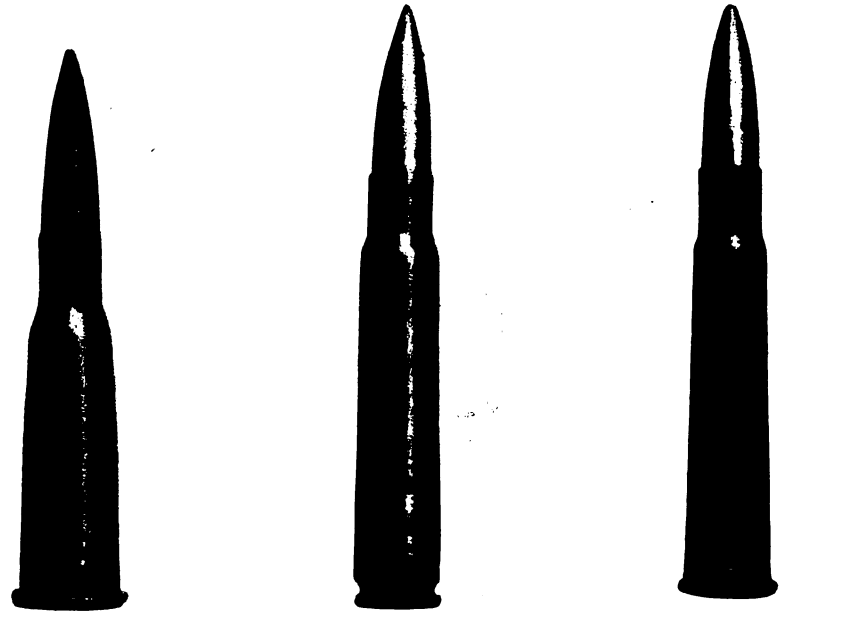


TYPES OF SHRAPNEL IN MODERN USE.

Bullets in modern warfare are all pointed and they tend to flow out of shape and to fragment upon meeting slight obstructions, because of the difference in the density of the core and the thin outer jacket. Because of its deliberately imperfect balance, it has a wabbly, gyrating motion during the first 800 yards of its flight, as well as when nearly spent. This imbalance often causes the bullet to somersault or turn on its axis when it meets the least

resistance, and if this resistance be that of the tissues, the bullet produces a deep, irregular wound often with large cavities in the soft tissues, as is typical of the dum-dum bullet. In this war, where the fight often takes place amongst houses, there are many opportunities for the bullet to be deformed and deflected. Again, the velocity and stability of a bullet is largely affected by passing through sand bags or a parapet, which, as a matter of fact, has to be about four feet thick in order to be bullet-proof.

There is plenty of evidence that, whether from adherent instability or from hitting some object, the bullet does spin, and in several cases a bruised impress has been seen on the skin which could only have been made by a sidelong impact of the bullet. Again, in those cases where two legs have been wounded by the same bullet, the first leg has been perforated by a small track, and the opposite leg has suffered a large gaping wound, the obvious explanation being that the bullet in passing through the first leg was made



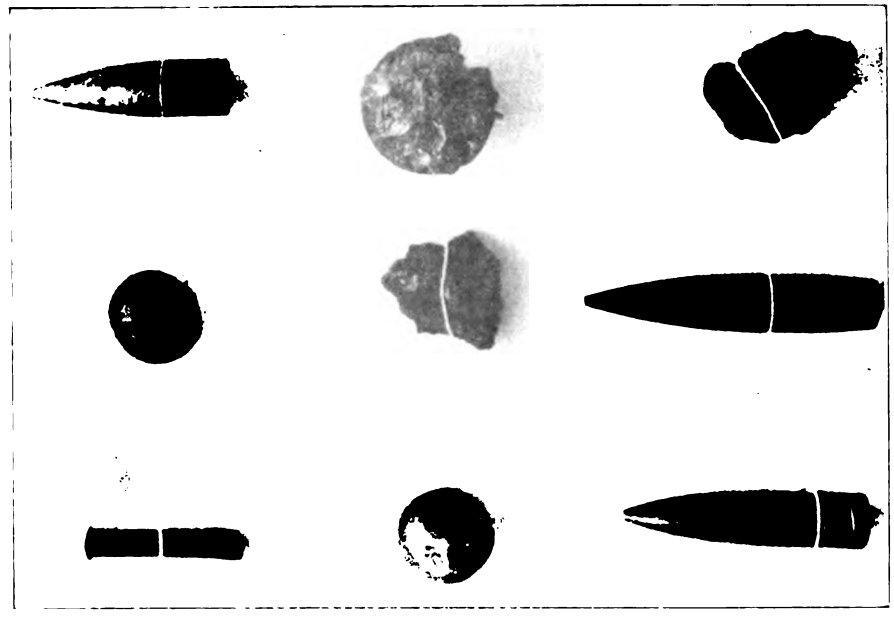
Actual size of French cartridge "D." | Actual size of German cartridge "S." | Actual size of English cartridge.

PRESENT-DAY CARTRIDGES.

to spin, and so caused a more extensive wound on the opposite member. A good deal has been said about the explosive effect of the modern pointed bullet, but the evidence shows that it is this gyrating and spinning action which causes the large, irregular, destructive wounds.

Captain Bashford (*Brit.-Jour. of Surg.*, January 1917, p. 452) has made an extensive gross and microscopical study of the tissues involved in gunshot wounds, and his conclusions follow: "Although the obvious local effects of gunshot wounds may sometimes be surprisingly extensive in their ragged ramifications, the foregoing observations show that remote and other far-reaching effects are by no means universal. Indeed, during eight months of close attention to so important a subject, I have failed to find any evidence that they

occur at all in the organs or tissues examined. If vibration be set up by the projectile in the tissues of the body, it does not result in capillary hemorrhage, except in situations where they would be expected—for example, under the capsule of the kidney; and remarkable disintegration of cells, or even injury of any sort at a considerable distance from the obvious site of the injury—have not been met with. The heavy infection of tissues by bacteria, effected by the passage of projectiles, would of itself serve to shake any belief in vibration being an efficient cause of cell-death, apart from the influence of direct violence. The facts set out above are all in favor of conservative surgery in gunshot injuries. By a too extended removal of tissues adjacent to the injury, the gap which has to be filled may often be made needlessly great, and the duration of the period of recovery needlessly increased, leaving out of all consideration



ACTUAL SIZE OF SHRAPNEL BULLETS AND PIECES OF SHELL.

Shrapnel wounds are accompanied by considerable destruction of the deep tissues in consequence of the "mushroom" effect of the soft, unjacketed lead missile, particularly when hard bone is encountered. These wounds are always infected, often very intensely.

other possible contingencies." He shows this point by many illustrations, some of which are reproduced here.

Bombs and grenades. In the early part of the war bombs were often extemporized, and consisted of tin boxes filled with an explosive, scrap iron, cobbler's nails and screws, etc. Now they are made of iron, the surface of which is marked with grooves, so that on explosion they break up into quadrilateral fragments. Sometimes the force of the explosive will cause the bomb to burst into smaller fragments often no larger than a matchhead. Although small, these fragments have, apparently from their high velocity, a very great penetrating power in the immediate neighborhood of the explosion, though this is rapidly lost as the distance increases.

Trench mortars. Bombs from these are of various shapes, but consist essentially of a very large, high-explosive charge with a comparatively thin containing envelope; they therefore very often burst into large ragged frag-

ments, as well as minute ones, and are generally timed to burst either on the surface or in the ground.

Bayonet wounds, although seldom met with, make up practically all the incised wounds seen in modern warfare. A direct thrust into any part of the body that allows of the passage of a bayonet is practically always fatal. Since bayonets are frequently used as accessory trench and camp tools, their wounds are nearly always infected. Wallace describes two cases: In the first the bayonet penetrated the man's back and emerged through his umbilicus; no viscus was injured, but the man succumbed to hemorrhage. The second was the case of a man who was late in answering a challenge and was bayoneted by the sentry; the bayonet entered the left hypochondrium, wounded the greater curvature of the stomach and entered the back wall of the abdomen. Though promptly operated upon, he died, not of his stomach wound, but of retroperitoneal sepsis.

Cuthbert Wallace (*British Jour. of Surg.*, IV, 1916, 684) gives interesting statistics which are as follows:

"*Relative number of different projectiles, and the proportion retained.*" The following table has been drawn up with the intention of giving some idea of the relative frequency of the different projectiles met with in abdominal wounds; it also shows the relative number retained in the body. This table must be taken as only approximately correct for several reasons. In the first place, it is often impossible for a man to tell what hit him. In the second place, one cannot always be sure from a study of the entrance and exit wounds what was the nature of the projectile; and again, many do not differentiate between high-explosive shell and shrapnel. As a matter of fact, there is very little difference in the nature of the fragments in high-explosive shells, bombs, rifle grenades, or trench mortars, if one excludes the larger fragments, with which we are very little concerned.

	Bullet	Shell Fragment	Shrapnel	Bomb or Grenade
Passed through and out	203	30	15	6
Retained	131	254	67	128
Total	334	284	82	134

Bullets. Bullets and high-explosive shells furnish a large proportion of wounds. More bullets pass through the body than any other projectile; the reason for this is obvious. The causes for retention are not so obvious, and I have known bullets, fired at a comparatively short distance, to remain within the body. In other cases the bullet may have passed through the earth and so have had its velocity diminished. Ricochets account for a certain number remaining.

Shells. These show a high proportion of retention, which is obviously due to the shape of the fragments.

Bombs and grenades. The retained fragments are strikingly in excess of those passed out.

The large proportion of retained fragments at once suggests the possibility of armour; and no doubt armour could be devised which would keep out many fragments. It really is more or less a question of what a soldier is able to carry. One cannot help being struck with the resistive power of an ordinary book, as one has often seen projectiles arrested by such articles when carried by the soldier. The great saving of life effected by the steel helmet make one hope

that something may be produced equally efficacious in protecting the body. Although we could not expect such shields to be supportable and at the same time bullet proof, yet the number of bullets is greatly outnumbered by shell and bomb fragments, which possess far less penetrative power.

	Bullet	Shell Fragment	Shrapnel	Bomb or Grenade
To base	91	105	15	60
Died	106	154	40	58
Total	197	259	55	118

Relative mortality of the different projectiles. The above table shows that bullets are but little less dangerous than shells, and that bombs and grenades are the least noxious.

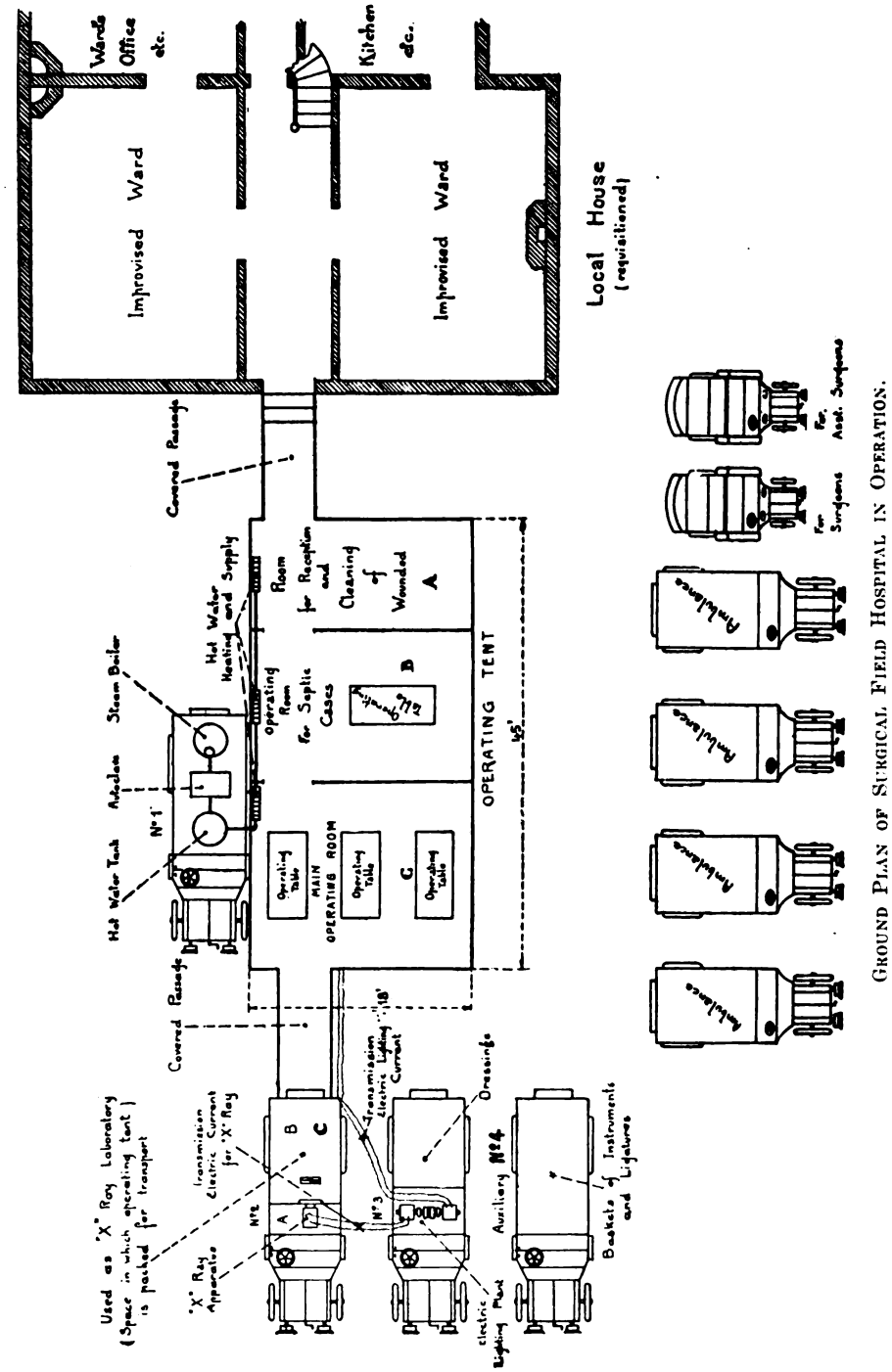
THE GENERAL CARE OF THE SICK AND WOUNDED

Aside from the control of severe hemorrhage and the fixation of fractures, the most important primary treatment is that of the general condition, for the psychic and physical shock is often of more importance in the recovery of the patient than is the treatment of his wounds later on. Bowlby, quoted by Mills, (*British Jour. of Surg.*, Dec. 25, 1915) illustrates this vividly: "When the intense excitement of fighting for life and killing other men in the midst of the crash of shells and the clatter of rifles and machine guns has passed, then there comes the reaction and the exhaustion of a tired-out man and an over-wrought nervous system. Those who only see the men in the base hospitals have little idea of the silence of a crowded room in a clearing station when heavy fighting has been in progress for a day or two. There are hundreds of men whose best chance in life is to be kept warm and left absolutely quiet and persuaded to take hot soup or cocoa before again going to sleep. It is at first surprising to find how many quiet, pulseless men will pull around if given time and kept thoroughly warm. Often they are so nearly dead that it may be several hours before an attempt can be made to dress their wounds, and even with every care there are not a few who die."

Numerous lives have been saved by the free subcutaneous and intravenous injection of normal saline, by proctoclysis of hot saline solution, coffee or brandy, and by hypodermics of an opiate to relieve pain. Efficient voluntary care of the stricken soldiers by nurses and town folks has done much to alleviate their sufferings.

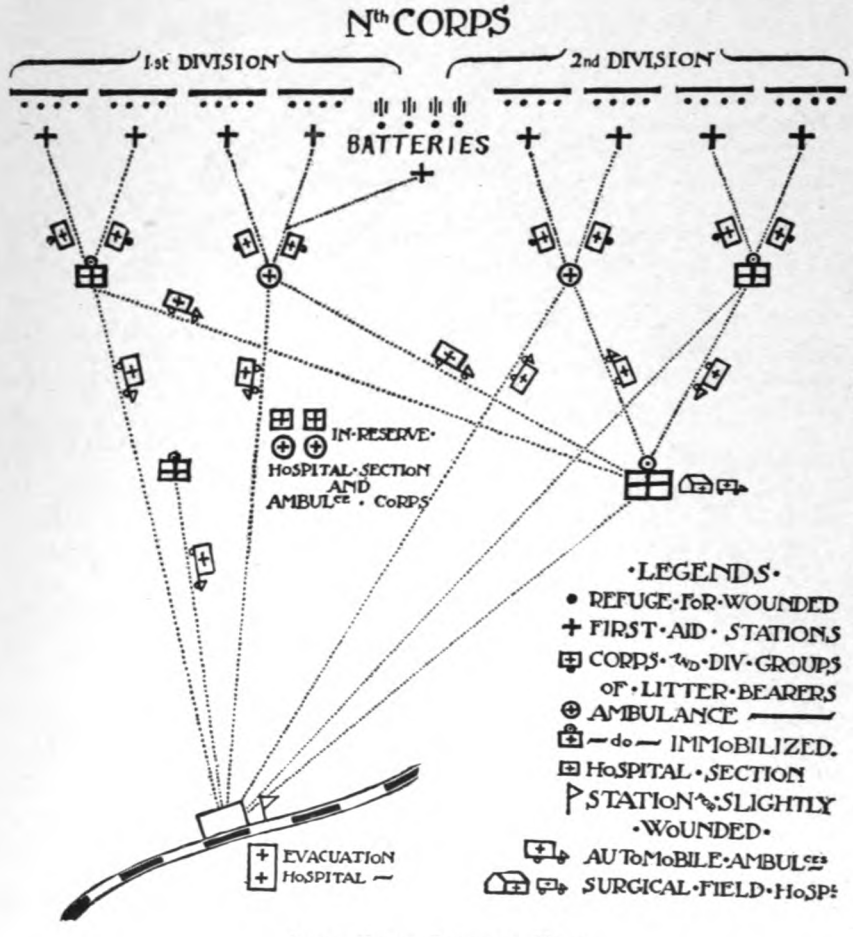
The patient should be given every consideration that is possible under the circumstances. He should be allowed to rest and not unnecessarily moved while in a condition of shock or pain. He should have plenty of fresh air and a good light room. General or regional anesthesia should be administered in procedures necessitating a great amount of pain. Morphine in doses of one-fourth to one-half grain hypodermically is usually allowed the men with pain during transportation.

The evacuation and care of the sick and wounded has always constituted a problem of the greatest importance in every campaign of history. Progress in this direction has not by any means kept pace with the advances made in perfecting the means for destroying human life and property. The history of every war has shown that the constant working formula, so often quoted, "ammunition first, food second, and wounded third," has not changed, nor has it received the consideration, in regard to alleviating the condition of the last factor in this formula, that its importance warrants.



GROUND PLAN OF SURGICAL FIELD HOSPITAL IN OPERATION.

Hospital organization and capacity in the battle-field have undergone many variations during previous conflicts and especially the present great war. The experience of George W. Crile, (*Jour. Am. Med. Ass'n*, LXIX, 4, page 292) who has been in charge of an American base hospital in France, is summarized as follows:



ARMY CORPS SURGICAL UNIT.

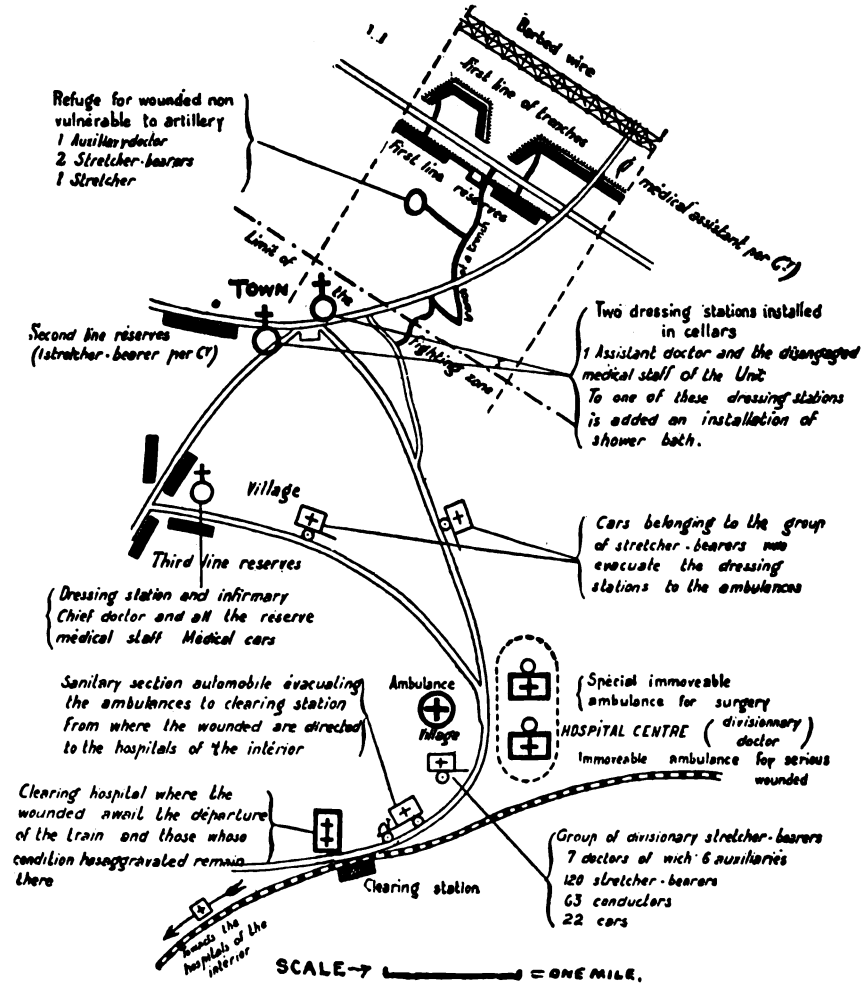
The first-aid station is in some sheltered spot, or the cellar of a house, usually from 500 to 1,000 yards behind the reserves, and is provided with water, large and small dressings and other facilities for the rapid treatment of wounds. Antitetanic serum is injected and the wounded then tagged and grouped for transfer to the rear. The diagram shows the disposition of the sanitary units and formations for one army corps. It represents the actual organization of the surgical work at the front, yet each unit or formation is to take advantage of any local protection, such as behind a hill. Therefore the distances to each group or station may vary, and the first-aid stations may be at convenient points at cross roads or in a village.

"1. On account of the remarkably wide and sudden fluctuations in the number of casualties, hospitals should be so constructed and their personnel so organized as to provide for a large crisis expansion.

"2. The newer base hospitals here have a capacity of from 2,000 to 3,000 beds. The capacity of the Casualty Clearing Stations (U. S. Evacuation Hos-

pitals) varies from 500 to 1,000 beds. The larger size has the following advantages: (a) economy in operation; (b) development of a strong professional staff; (c) large convoys can be cared for—the sick and wounded must be considered on a wholesale and not a retail basis.

"3. The hospital grounds should be in excess of present needs to allow for rapid expansion for crisis needs.


Barbed wire
First line of trenches
First line reserves
Refuge for wounded non vulnérable to artillery
1 Auxiliary doctor
2 Stretcher-bearers
1 Stretcher
Limit of the
TOWN
Second line reserves (1 stretcher-bearer per Cy)
Two dressing stations installed in cellars
1 Assistant doctor and the disengaged medical staff of the Unit
To one of these dressing stations is added an installation of shower bath.
Village
Third line reserves
Cars belonging to the group of stretcher-bearers who evacuate the dressing stations to the ambulances
Dressing station and infirmary
Chief doctor and all the reserve medical staff Medical cars
Sanitary section automobile evacuating the ambulances to clearing station from where the wounded are directed to the hospitals of the interior
Ambulance
Village
Special immoveable ambulance for surgery
HOSPITAL CENTRE (divisionnary doctor)
Immoveable ambulance for serious wounded
Clearing hospital where the wounded await the departure of the train and those whose condition has aggravated remain there
Clearing station
Group of divisionary stretcher-bearers
7 doctors of wich 6 auxiliaries
120 stretcher-bearers
63 conductors
22 cars
towards the hospitals of the interior
SCALE → = ONE MILE.

DETAIL OF SURGICAL FIELD SERVICE.

Shows actual organization of service immediately behind the trenches, where the conformation of the ground, the particular character of the fighting and the strategic necessities have called for these special dispositions.

"4. The hospitals should be so planned that patients may be conveyed to all parts on wheels. If patients must be carried, there is always the chance, in the strain of a crisis, that the bearers may become exhausted and the whole system break down. It is very difficult to plan for receiving and caring for say 800 patients in a day, yet there have been many times in the experience of every active hospital when more than half of its entire capacity was thrown

upon it in a day. There is 'feast or famine.' Nothing could be more regrettable than to fail to provide sufficient capacity for emergencies.

"5. *Crisis expansion* is splendidly provided for in British hospitals by tents containing closely-placed rows of board cots. These are not used during quiescent periods, but are filled in crises. Emergencies are further planned for in advance by the continual evacuation of patients to the home stationary hospitals.

"6. The receiving organizations also must provide for crisis expansion: (a) It should be so arranged that the entire hospital can be filled within twenty-four hours. (b) To avoid blockade, the point of exit for the ambulances should be opposite the point of entrance. (c) The space should be so arranged and the reception personnel—stretcher-bearers, etc.—so organized that a number of ambulances can unload simultaneously, and the patients be distributed to their cots with no confusion and with minimum delay.

"7. The casualty clearing hospital is the bag for the field hospitals; the base hospital for the casualty clearing hospitals. Crises must be planned for in advance by constant evacuation all along the line."

The task of evacuating the wounded, even at its best, is a complicated one, and there is no other class of military work which undergoes such startling and unexpected variations. For this reason the military surgeon must not only be skillful professionally, but he must be a man of above the average courage and resourcefulness.

"Le service sanitaire," or as it is also called, the "Service de santé," is the French organization, under the ministry of the war, which has charge and direct control of everything to the sick and wounded, from the time they leave the trench or firing line, on through the various intermediary stages, and until they are discharged from treatment at a base or auxiliary hospital. There are two distinct branches to this service, one being called the "service of the advance," which works exclusively in the zone of the armies, and the other being called the "service of the rear," which later takes up the entire medical and surgical work of the "zone of the interior." The following table, reproduced from Fauntleroy's report to the United States Government in November 1915, shows the organization and disposition of the sanitary units and formations for one army corps.

The French Red Cross, or "Croix Rouge," is a society of considerable proportions, even in times of peace, with ramifications throughout the Republic, and is organized along the lines of the same societies in the United States, England, Germany and Russia. It is supported, as in this country, by voluntary aid and subscriptions, and since the outbreak of the war has enormously increased in size and usefulness. Indeed, it is not too much to say that the continuous efforts put forth by different branches of this society are largely responsible for the comfort of the soldiers in the field and also of the wounded in the many hospitals scattered throughout the country.

TREATMENT OF WOUNDS

The treatment of wounds constitutes the greatest single problem of military surgery, and it is in this respect that eventful advances have been made in the practice of surgery. Due to the many different schools concerned, there have been a large number of ways of treating wounds on the battle-field and in the base hospitals. However, on the whole, there have been reported much better results during the last year than during the first months of the present war.

A general plan of treatment as accepted by the majority of workers is as follows:

1. Primary treatment—excision of the parts.
2. Extraction of foreign bodies.
3. Treatment of infection.
4. Secondary suture.
5. Later or plastic surgery.

Primary treatment of wounds. In case of simple perforation of the soft parts with small wounds of entry and of exit produced by pointed bullets, no interference is necessary or desirable. Tincture of iodine should be applied to each wound and a small dry dressing applied. It is the practice in some of the hospitals to excise the injured skin about the small wound in order to prevent a small amount of sloughing which sometimes occurs.

In rifle-ball, shrapnel and shell wounds which demand operation, it is now the practice in many clinics, although by no means universal, to excise those tissues which have been damaged by the projectile, in the hope of removing all infection and all devitalized tissue. The incisions should be complete enough not only to allow for liberal drainage, but to admit of the removal of all foreign material. In shell wounds the ragged tissue, especially fascia, should always be removed along with unattached bone and foreign bodies. Shrapnel wounds resulting in the destruction of deep tissues are to be similarly treated. If possible, an X-ray plate of the affected part should be obtained before operation. This, however, is not always practicable, as sometimes a large number of wounded will arrive at the same time, so that delay for an X-ray plate is not justifiable. Fenestrated rubber tubing is in more or less general use for insuring drainage, although a few instances of pressure necrosis have recently been reported as due to the presence of the foreign body in the wound. As a principle, however, it is always best to interpose an inert substance, such as rubber or glass, in order to maintain drainage during the first few days after an operation.

Very serious results, and even death, are often produced from the infection, unless the dead, contused tissue is unsparingly cut away, foreign bodies removed, the best drainage provided by means of rubber or gauze wicks wet in sodium hypochlorite solution, and lightly, but effectually, placed into every recess of the wound and frequently changed. Above all, such dressings should not be "waterproofed" with rubber tissue or other impermeable coverings, as such procedures usually result disastrously to the patient because of the lack of drainage thereby produced. Where such treatment is instituted promptly, little or no pus forms, foul wounds clean themselves quickly, vigorous granulations spring up, and the treatment resolves itself merely into that of a large granulating wound. Of course, all such cases receive antitetanic serum immediately. In view of the initial destruction of tissue, the final deformity is often surprisingly slight.

Treatment of infected wounds. According to Lloyd Mills (*Amer. Encycl. of Ophth.*, Vol. X.), careful clinical and bacteriological study of battle wounds has solidly established the following facts:

"1. The prevention and cure of infection constitute the greatest problem of military surgery.

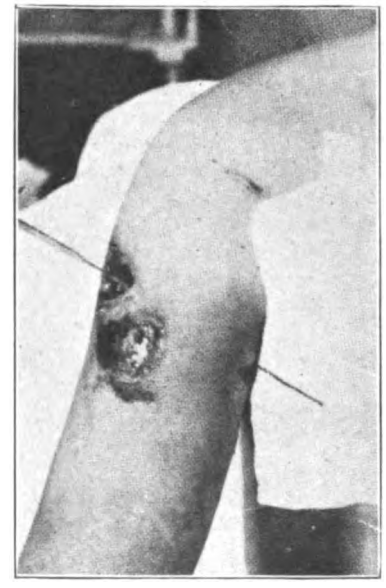
"2. Little or no bacterial growth occurs in projectile wounds during the first four to six hours following injury. Such as does occur comes mainly from implantation of organisms with the projectile or secondary missiles, and where these wounds can be effectually opened and cleansed of foreign material before bacterial growth extends to and into the surrounding tissue, infection does not occur, or is almost negligible.

"3. Wherever, from the nature of the wound, it is possible to excise

the bruised and contaminated tissue about the path of the missile, the usual result is primary union.

"4. If, owing to faulty transport, excessive casualties, or extreme shell-shock or exhaustion, prompt surgical care is impossible and infection spreads to all parts of the wound, free incision, adequate drainage, the use of light dressings frequently changed, and continuous irrigation offer the surest means of recovery."

The use of antiseptic solutions in battle wounds has undergone much revision as the result of the brilliant and painstaking researches of Almroth Wright, Carrell, Dakin and many others, who have shown the uselessness of merely washing pus out of infected wounds without directing treatment to the walls of the wound where the delicate biological changes of tissue resistance to bacteriological invasion are taking place. Two solutions stand out among the many advocated for continuous irrigation and wet dressing: Wright's solution of 5 per cent. sodium chloride with 1 per cent. citrate has for its object the 'lymph lavage' of the infected tissue by introducing this fluid of high osmotic properties freely into every part of the wound, while Dakin's



A Perforating Wound with Comminuted Fracture of the Upper Arm.

solution of sodium hypochlorite, similarly employed, is an effective antiseptic without the albuminotropic properties, which make solutions of bichloride of mercury or of iodine or phenol objectionable. Dakin's solution is made by adding 200 grams of chlorinated lime to 5 liters of tap water, allowing it to macerate over night. To this is added a solution of 100 grams of anhydrous sodium carbonate and 80 grams of sodium bicarbonate in 5 liters of cold tap water; the mixture is stirred vigorously for a minute and then the calcium carbonate is allowed to precipitate. After a half hour, the supernatant fluid is filtered through a paper and is ready for use without heating.

Lewis A. Stimson (*Jour. Am. Med. Ass'n.*, p. 1687, Dec. 2, 1916) gives the following formula of Dakin's solution, which he obtained from Dr. Carrell at Compiègne in May, 1916:

1. Chlorinated lime (bleaching powder).....200 gm.
   Sodium carbonate, dry.....100 gm.
   Sodium bicarbonate ..... 80 gm.

2. Put the chlorinated lime in a 12-liter flask with 5 liters of ordinary water, and let it stand over night.

3. Dissolve the sodium carbonate and bicarbonate in 5 liters of cold water.

4. Pour (3) into the flask containing (2), shake it vigorously for a minute, and let it stand to permit the calcium carbonate to settle.

5. After half an hour siphon off the clear liquid and filter through paper to obtain a perfectly limpid product. This must be kept protected from the light.

The antiseptic solution is then ready for use; it contains about 0.5 gm. per cent. of sodium hypochlorite with small amounts of neutral soda salts; it is practically isotonic with blood serum. It should meet the following tests:

Test. Put about 20 cc. of the solution in a glass and pour on its surface a few centigrams of phenolphthalein in powder; shake it with a circular movement, as in rinsing; the liquid should remain colorless. A more or less marked red discoloration indicates the presence of a notable quantity of free alkali, or incomplete carbonation inputable to an error in technique.

Errors to be avoided. Never heat the solution. If in an emergency it is necessary to triturate the chlorinated lime in a mortar, do so only with water, never with the solution of the soda salts.

Tritration. To 10 cc. of the solution add 10 cc. of distilled water, 2 gm. of potassium iodid and 2 cc. of acetic acid. Pour into this a mixture of decinormal (2.48 per cent.) solution of sodium thiosulphate (hyposulphite) until it is decolorized. The number of cubic centimeters of thiosulphate employed multiplied by 0.03725 equals the percentage of sodium hypochlorite in the solution.

The efficacy of nearly all of the numerous other solutions which have been urged in the treatment of battle wounds depends mainly upon their high osmotic properties. Most prominent among them are various strengths of sea water or of solutions of sea salt; 50 per cent. glucose; 5 per cent. sodium benzoate; magnesium hypochlorite; magnesium sulphate, advocated by Morison and Tulloch, in a solution of 40 ounces of the salt to 30 ounces of boiling water and 10 of glycerine; magnesium chloride in 1.2 per cent. solutions of the anhydrous and 1.7 per cent. of the crystalline salt (Delbet and Karajanopoulo); and finally, Locke's, Ringer's, and Schiassi's artificial serums, urged with much enthusiasm by Soubeyran as nutrient serums during the reparative stage of wounds. All of these solutions have the common advantages of comparative painlessness and cheapness.

Surgical opinion has not yet crystallized on the use of vaccines in the treatment of battle wounds. There is much favorable clinical testimony, often of a striking nature, and in doubtful cases, or in those in which a smear shows streptococci, a prophylactic injection of vaccine containing streptococci, staphylococci and the bacillus of Welch seems indicated.

Bismuth paste similar to the preparation introduced by Dr. Emil Beck of Chicago some years ago, is now being used quite extensively for the treatment of infected suppurating war wounds.

The treatment is given as follows:

1. Under an anesthetic the wound and surrounding skin are prepared by swabbing with 1-20 carbolic acid or with tincture of iodin.

2. The wound is opened freely to allow of inspection of its cavity. Portions of macerated tissues, foreign bodies, clothing, etc., are removed. In so doing special regard must be paid to nerve trunks and muscular branches of nerves, since the division of blood-vessels, excepting the largest, and of muscles themselves, does little harm as compared with that of the disability following nerve damage.

3. Fill up the entire cavity with bismuth paste, dress the wound with

sterile gauze, and apply a bandage. This dressing requires no change for several days if the patient is free from pain and constitutional disturbance.

Beck's bismuth paste is a mixture of one part of bismuth subnitrate in three parts of yellow vaseline. This mixture has proven efficacious in a large number of cases of subacute or chronic inflammations with cavity or sinus formation. Its use is especially indicated in old tuberculous abscesses and in osteomyelitis.

The British and French have recently used a bismuth iodoform paste, called "Bipp," which is made up as follows:

Bismuth subnitrate	8 oz.
Iodoform	16 oz.
Liquid paraffin	8 oz. (approx.)

The powders are mixed together in a mortar and the liquid paraffin incorporated. The quantity of liquid paraffin required varies according to the bulk of the powders, the bismuth in particular being liable to a considerable variation in bulk. A sufficient quantity should be added to form a paste. It is then advisable to rub down the paste, in small quantities at a time, on a slab with a spatula, to insure freedom from grit and dry particles of powder.

Secondary suture may be defined as any suture of a wound not performed within the first 24 hours. There is considerable scope for it in the surgery of war wounds, where large granulating surfaces so often result, either from the nature of the injury itself, or from extensive incisions called for in the course of treatment.

Successful suture saves time—sometimes many weeks or even months; it also obviates to a large extent the pain and disability resulting from adherent cicatrices. A careful bacteriological examination of the wound must be made before attempting to close it up. There should not be more than one or two organisms to the field of the microscope in a smear made from the surface of the wound. Any wound may be closed in this manner provided that: (1) the skin edges come together without undue tension; (2) the surrounding skin is healthy; (3) the wound surfaces can be approximated so as to obliterate all dead spaces; (4) the bacteriological report is favorable. Deep silkworm-gut sutures are used which at once bring together the deep tissues and the skin, without the formation of pockets.

Paraffin treatment. There has been introduced since the first months of 1917 a new and useful treatment for the open granulating wounds so often seen in the convalescent stages. Heretofore it has usually required weeks, and sometimes months, for these granulating surfaces to become clean and epidermized. In cases of extensive infected wounds which are too broad and too shallow to allow of secondary suture, these wounds are cleaned first by one of the methods previously described, so that there are but very few or no organisms present in smears made from the wound secretion. A mixture containing paraffin is then applied in the following manner: The mixture is heated over a water-bath until it is just melted and a layer painted upon the surface of the wound to its edges by means of a fine, broad camel's hair brush. A very thin (2-3 mm.) layer of absorbent cotton is next applied over the paraffin, then another layer of paraffin, and then cotton, until three to four layers have been applied. This dressing is left in place for 24 hours, when it is peeled off and another similar dressing applied. By this method wound surfaces are rendered clean, the granulations become healthy, the epithelium grows more rapidly, and the part is placed in good condition for skin-grafting, if necessary. An additional advantage of the dressing is in the absence of pain. The patients so treated are rendered quite comfortable.

Several different mixtures have been used in the present war, one of which,

called "Ambrol," has been very successfully employed by H. C. Schumm in Vienna, who has introduced it in our clinic. It is made up as follows:

Paraffin .....12 parts.
Yellow beeswax ..... 1 part.
Resin cereate .....½ part.

This mixture is heated over a water bath just before using as described above. The paraffin should be of good grade with a low melting point. Where such a grade of paraffin cannot be obtained, a small amount of liquid paraffin may be added which answers practically the same purpose in lowering the melting point. The paraffin used, according to Leech, should be liquid at or below 50° C. and a thin film should be pliable at 28° C. and ductile at 31° C.

Gas-bacillus infection. Before the principles of early cleansing of wounds, free drainage, and continuous irrigation, were clearly established in the present war, the incidence and mortality of tetanus and gas-bacillus infection were appalling. Bruce in his early work reported a mortality of 57.7 per cent. out of 231 cases.

GAS BACILLUS INFECTION.

Spread of bacilli across the muscle along the track of the large vessels, and longitudinally between the muscle fibrils along the capillaries. Note absence of leucocytes.

A recent contribution by Judd upon this subject is here given in summary: Modern trench warfare with the accompanying difficulties in providing cleanliness, exposes a large proportion of wounded to the dangers of gas-bacillus infection. The majority of these cases show shell wounds where a piece of contaminated clothing was carried into the depths of the wound by the projectile. Among the varieties of micro-organisms in the wounds, the bacilli perfringens are generally accepted as causative organisms. These bacilli appear in the wound from the ninth to the twelfth hour. The aërobic bacteria appear about the forty-eighth hour. The symptoms of the infection appear early, usually on the second day. The parts of the body most often affected are the legs, on account of the likelihood of their becoming contaminated by dirt and fecal matter.

It is of vital importance that the diagnosis be made early. Pain, swelling and tension of the wound, with rapidity of the pulse, are important early symptoms. Vesicles, discoloration of the skin, gas-formation and odor should be considered later symptoms. The prognosis depends upon whether the patient receives proper early treatment. Trench hygiene and personal cleanliness are vital prophylactic measures. Early incision of the wound with removal of the foreign bodies, cleansing of the wound, and excision of damaged tissue doomed to slough, are the correct surgical procedures of prevention. When the infection is once established, well-placed, deep incisions, exposing the deeper tissue to the air, are indispensable. For the clinical treatment of the wound, Dakin's solution has given the best results.

THE MICROSCOPIC APPEARANCE OF GAS GANGRENE IN SEGMENTED MUSCLE.

Showing the total destruction of tissue in the central portion which is crowded with bacilli and leucocytes.

Gas-bacillus infection has proven one of the worst dreaded of the late conditions seen in the base hospitals, particularly in France and Germany, and although there has been a marked decrease in the disease, the mortality remains almost as high as at the beginning of the war. The virulence of these infections is usually so great, and is evidenced by such rapid growth, that the patient has a very poor outlook, as a rule, from the beginning. When such infection begins in an extremity, some men prefer to amputate at once, because of their lack of faith in any radical treatment short of total excision of the part. There is no doubt, however, that free incision with thorough drainage and proper antiseptic precautions instituted early, will in most instances abort the disease.

Tetanus infection. One of the most brilliant results of the work of the sanitary services of the different armies has been the enormous reduction in

incidence and mortality of tetanus bacillus infection. At present all cases of open wounds caused by rough fragments, upon arrival at the hospital, are given prophylactic doses of tetanus antitoxin. The dosage varies from 500 to 2,000 units, with a probable average of about 1,000 units. The danger of anaphylactic shock is said to be negligible when anaphylactic doses of 500 U. S. A. units, contained in 3 cc. of horse serum, are administered subcutaneously, no matter what the interval after the preceding injections. The same precautions should be observed in the open treatment of wounds or infections, as in gas-bacillus or other virulent infections.

When a case has developed the signs or symptoms so well recognized of tetanus, it is best to give at once massive doses of tetanus antitoxin. These should be given subcutaneously and intravenously, 5,000 to 10,000 units in the area surrounding the wound. A lumbar puncture should then be made and from 30 to 40 cc. of cerebrospinal fluid allowed to escape, after which is injected 10,000 to 20,000 concentrated units. Even higher doses than these are advocated by some, such as, in some instances, 90,000 to 100,000 units. Clinical evidence points to the fact that the curative value of tetanus antitoxin depends upon the amount of the antitoxin which is given at the very onset of the symptoms. There have been reported a greater proportion of recoveries when large massive doses were used as soon as the symptoms were noted.

FOREIGN BODIES

The question as to whether retained bullets should or should not be removed has been discussed at great length by a large number of workers. The predominant opinion, however, is that foreign bodies should be removed if possible at the first operation. This is particularly true of large, ragged, metallic fragments, because these tend to prevent the complete healing of an infected wound. Occasionally, however, bullets are found imbedded in soft tissues, such as the muscles, where they produce absolutely no symptoms. Even in these cases, it is found that the patient is usually extremely desirous of having the bullet removed because of his knowledge of its presence. However, when the localization of a bullet is liable to require so much traumatism in the field of an infected wound, it is best to first treat the infection and later remove the object, because of the danger of reinfecting fresh portions of tissue.

Localization of foreign bodies. No single accurate method has been advocated and used for the finding of various forms of missiles deeply imbedded in the tissues. When composed of metal, the X-ray is, of course, a necessary adjunct in finding and localizing a foreign body. The great disadvantage, however, has been in a tendency to make the procedure with the X-ray altogether too complicated and intricate. Many so-called exact and scientific methods have been devised, which often are less accurate, require more time, and are much more expensive than the simpler methods. It is a general rule in surgery that when an object can be attained by one of two methods, a simple and a complex, the former should always be chosen.

There are three good simple ways of localizing these missiles. The first, and probably the most extensively used, is that of making two radiographs, each of whose plane is at right angles with the other. This method is satisfactory in practically all cases of injuries to the extremities, but usually does not apply to such portions of the anatomy as the hip, abdomen, or other parts of the trunk. This method is the one in most common use in France and England. A second method is that of stereoscopic radiography, and this method has proved very successful in most instances. There is the disadvantage, however, that a thoroughly stereoscopic effect is not always produced

upon the plates, and also that some individuals do not visualize the plates stereoscopically.

A method which seems to us the most practical and consistent is the following:—The patient is brought to the X-ray room and all preparations made for the operation to be performed there. A fluorescent screen is then interposed between the patient and the eyes of the operator or one of his assistants. This is best done by means of the apparatus devised by Bettman, and called a "cryptoscope." This consists of a light-tight, cardboard box the shape of a truncated pyramid, held over the surgeon's eyes by means of a strap. The base of the pyramid, which is 18 x 13 cm. in size, is composed of a fluorescent screen which is on a hinge and when released from a catch by pressure on a button flies open under the influence of a spring. A piece of lead glass is inserted into the box to act as a shield. When the base is pulled down into position, the surgeon is looking into a light-tight box, upon a fluorescent screen. A very simple method for making rough localizations, especially in the extremities, is simply to fluoroscope the parts in as nearly as possible a perpendicular direction, marking the projections of the foreign body on the skin with blue pencil. Another common and very satisfactory method is to rotate the patient under the fluoroscope, keeping the distance from the bullet to the skin in mind and ascertaining where this is the smallest. This distance is, for all practical purposes, the depth of the bullet. Then with a skin-marking pencil, the site of the bullet is indicated, by encircling the skin with a pencil held parallel to the screen. The pencil point marks the site of the bullet when the whole pencil is outside of the shadow of the soft parts.

Eastman and Bettman's method of actual removal of foreign bodies by means of the cryptoscope is as follows: "The presence of the bullet is determined by the method just described. The path of attack has been planned, the skin area prepared in the usual manner, and the patient placed on the X-ray table as upon an operating table. A tube, preferably a Coolidge tube, is placed under the table stage. The field of operation is lighted by daylight or strong artificial light. The cryptoscope is covered by a sterile cloth and placed over the eyes of one of the assistants. He closes the screen on the base of the apparatus, the X-ray machine is set in function, and the assistant may localize the bullet as he would with the aid of the usual fluorescent screen in a dark-room by means of a metal instrument. The surgeon makes a small incision, working down to the bullet, being guided by the assistant who is watching the operation on the fluoroscope, and who guides him verbally or by means of a pointer down to the bullet. It will often happen that after the incision has been made, the assistant himself, by blunt dissection with a forcep can separate the tissues and grasp the bullet. He sees the silhouetted clamp approach the metal shadow. He sees this shadow move with every little impulse of the clamp when he has reached it. As he opens the clamp slowly, he can see the jaws stretch over the bullet. He can see that he has grasped the bullet. He then releases the screen, and in full light very carefully, so as not to cause any injury to neighboring tissues, he withdraws the bullet. Great care must be taken in doing this. * * * Often in simple cases the surgeon himself wears the cryptoscope, operating with the screen released and orienting himself from time to time by closing the same and working at the bullet with the fluoroscope. * * *

"The results have been striking in many cases. Bullets for which a long search has been made after repeated searches, have been quickly removed

when the search was aided by the cryptoscope. Time and again the surgeon was unable to find the bullet until the roentgenologist pointed to the location of the bullet in the walls of a wound, or under a retractor. The average time for a foreign body operation has been reduced fifty to seventy-five per cent. Tissues are not needlessly traumatized, nor are large wounds made where small ones suffice. We have also used this method with similar success in a few cases of needles in the hands of some of our hospital servants, and warmly recommend its use for such cases."

AMPUTATIONS

Many limbs are now being saved in military surgery that in previous wars were amputated. The reason for this is that by the modern treatment of wound infections and bone lesions the prognosis is much more favorable than formerly. Even during the present great war there has been noted a marked decrease in mortality following, and in the number of cases of, amputation of limbs. In the 1,800 wounded treated by Proust in 1915, there were 152 plane section amputations with a mortality of 15 per cent., distributed as follows:

52	thigh amputations	.....	47 per cent. mortality.
31	leg "	.....	16 " " "
9	foot "	.....	18 " " "
29	arm "	.....	27 " " "
18	forearm "	.....	55 " " "

The mortality, however, has markedly decreased under better conditions, so that it now averages only about 8 per cent.

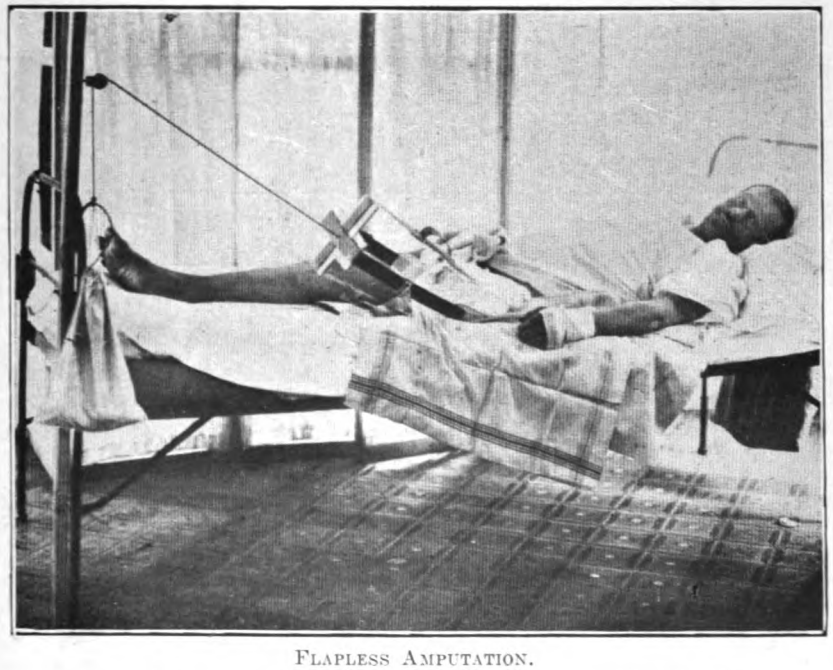
In the hospitals at the front during the first few months of the war, there were horrifying accounts of the ravages of gaseous gangrene, and of the appalling results of amputation. The condition is rarely seen at the base, due to the good work of the clearing hospitals; but, in the early days, it was quite common. Patients were received at the base hospitals with large segments of the limb, often above the elbow or knee, in a totally gangrenous condition, and a large area of the limb was hard and brawny, with the typical brown discoloration frequently extending to the trunk. Even as severe a condition as this is amenable to circular or flapless amputation, when done early enough.

Gaseous gangrene. In these cases there is a spreading infection, often of most appalling virulence. Part of the limb is gangrenous and crepitating, often with gas-containing bullæ in the skin, and beyond this part is an infiltrated edematous area, with a yellowish-brown staining of the skin, which rapidly becomes involved in the gangrenous process. Often no healthy skin is left on the limb, and experience has shown that flaps cut from the threatened tissue almost invariably slough and become the starting point of a further spreading infection. If, on the other hand, a flapless amputation is done, close to the edge of the gangrenous parts, recovery of the threatened tissue is the rule, and not only is life saved, but a maximum economy of the limb is achieved.

Especially important cases are those in which the gangrene is close but not up to the knee, hip and shoulder joints. In gangrene reaching to just below the knee—a very common variety—a flap amputation, to be safe, would need to be through the middle or upper third of the thigh. If, however, the skin can be divided just below the knee and the bones sawed below the tubercle

FLAPLESS AMPUTATION.

Showing an amputation stump of a case of progressive emphysematous necrosis (gas-bacillus) infection with adhesive straps applied for traction upon the skin.



FLAPLESS AMPUTATION.

The completed dressing and apparatus for skin traction in position in the same case as preceding illustration.

of the tibia, there is little retraction of the skin, since the quadriceps and hamstrings are intact, and there is plenty of material for a trans-condylar amputation later. Similarly, at the hip-joint, a transverse amputation, which is practically the first stage of an Esmarch amputation, often saves the situation, while the mortality from disarticulation at the hip-joint is so great as to make it almost unjustifiable; and at the shoulder, it can be used as the first stage of a shoulder-joint amputation, when immediate disarticulation would be much more risky.

FLAPLESS AMPUTATION.

The same case as the preceding showing the improvement in skin growth over the stump at the end of two weeks.

Compound comminuted fracture. These cases in war wounds due to shells differ from those one encounters in civil practice. In the compound fractures we are accustomed to treat in peace time, the protruding bone is perhaps infected, but the infection is usually not severe and is confined to the protruding bone and the immediate focus around it—that is, it is strictly localized. In gunshot fractures, on the other hand, a piece of metal enters the limb, carrying with it pieces of clothing coated with mud from a highly manured soil; it strikes the bone with explosive violence, splintering perhaps five or six inches of the shaft and lacerating the soft tissues widely; and the exit wound is an enormous rent made by pieces of bone as well as the projectile. This area of broken bone and lacerated tissue and blood-clot, perhaps as large as a cocoanut, is at once infected with anaërobic and pyogenic organisms.

In these conditions, local cleansing at the earliest possible moment and free drainage do what they can; when these fail, and the patient's life is in danger, amputation is called for. In such a case the infection is very widespread; the whole limb is edematous, and a flapless amputation, at or above the site of fracture, is the best treatment.

Multiple wounds. These are fairly common in later war surgery, and are usually the result of bomb injury. It often happens that a hand or a foot is mangled almost beyond recognition, and that the rest of the limb is literally peppered with fragments, every one of them causing a septic wound. Here a flap amputation is out of the question, and a simple transverse section of the limb, with a cleansing up of the septic area, is the best course.

Fitzmaurice-Kelly believes that the flapless amputation is best because, (1) it saves life and length of limb; (2) the risk of secondary hemorrhage is lessened and arrests the spread of infection, whereas in flap amputations sepsis often recurs in the flaps and spreads up from their base; and (3) it is often practicable where no other method is possible.

Technique. The methods of making the flap amputations are so well known that only the circular amputation will be described here.

The skin and deep fascia are divided, usually in circular fashion, but sometimes more skin can be utilized by making the incision oblique. After retraction has occurred the muscles are divided at the level of the retracted skin, not too quickly, so as to allow a retraction of the layers; then the bone is sawed flush with the muscle, the vessels are ligated and the nerves carefully shortened. The surface is slightly concave at first, if the operation has been properly done, but soon becomes convex from further retraction. This, however, once the part is fairly clean, is easily overcome by extension from adhesive strips placed above the wound. In this way the loss by retraction may be made up and it is usually not necessary later to do more than remove a length of bone from the shaft.

CRANIAL INJURIES

General consideration of projectile injuries of the skull and brain. Projectile wounds of the cranium have long been divided into *tangential wounds*, which are notable for the amount of cortical destruction which they produce and the relative frequency with which they are survived; *penetrating wounds*, with lodgment of the missile, and *perforating wounds*, in which the missile, practically always a rifle bullet, has passed through and emerged from the skull.

The experiences of recent wars, but more particularly of the present conflict, have been so enormous, however, and the effects of wounds of certain cortical regions so constant in their symptomatology, that subdivisions of cranial wounds, according to the region involved or the symptoms produced, are necessary.

The great number of points in the brain at which the optic centers and connections may be wounded or involved makes necessary a brief study of cranial wounds in general, their treatment and results.

The signs and symptoms of projectile injuries of the cranium are identical with those of all similar skeletal injuries (bleeding, pain, dislocation and functional disturbance resulting), but being kept more or less in the background by the symptoms of injury of the brain or its envelopes. Every projectile wound of the cranial vault, whether this is fractured or not, affects the underlying brain, which reacts to insult like all other tissue and to a degree corresponding to the extent of the trauma. Where no fracture, or merely a slight depressed fracture, has occurred, the reactive edema of the meningeal tissues, the cortex and the subcortex causes the brain to swell and to tend to become too large for the skull, even in the absence of local hemorrhage. This is further exaggerated by the presence of an actual serous meningitis when the reactive inflammation becomes excessive. With severer trauma this edema is complicated by arterial hemorrhage, laceration of the venous sinuses with hemorrhage, thrombosis and obstructive edema of the cortex, and

mechanical damage of all degrees to the nerve elements and their mutual associational connections. Intracranial suppuration is the cause of death or of further disablement in nearly all cases which survive the initial injury.

The amount of immediate functional disturbance depends on the location of the injury not less than on its extent, for certain portions of the brain, notably the frontal regions, are amazingly tolerant of physical insult, while the array of recoveries, as to life and to a lesser degree as to vision, after tangential shots of the occipital region, is already formidable.

A number of cases of complete recovery after through-and-through perforations of the skull have been reported and the cases of penetration and lodgment in nearly all parts of the brain by all sorts of missiles, which have recovered to a more or less good condition, without or after operation, are many.

The study of the late results in these cases of brain injury is disappointing, but it is altogether probable that the present era of finished plastic surgery in the closure of cranial defects and the prevention of large cerebral scars will go far toward averting the constant headaches and the undue sensitiveness to sunshine which are the common and enduring results of nearly all these injuries. It will also radically lessen the frequency of cortical and subcortical softening, cyst formation, unduly large cerebral scars, the various forms of Jacksonian epilepsy and the chronic, diffuse or localized meningo-encephalitis which appears so insidiously within a few weeks or months, and which may lead to death through sudden and unheralded coma, or gradually, after a prelude of sphincter troubles and mental disturbance. Psychological research after this form of cranial injury often discovers latent psychic defects in surprising ways.

Lapointe (*Jour. Amer. Med. Ass'n.*, July 31, 1915, p. 441) declares that the immediate seriousness of cranial wounds in cases that survive to reach hospital care depends on the continuity of the dura. If this is intact, the immediate mortality is about 7 per cent., as opposed to a mortality of 56 per cent., due to infection in nearly every case in which the brain substance is involved.

Joseph (*München. med. Wchnschr.*, Aug. 31, 1915) is so much of the same opinion that he divides cranial wounds into those with intact, and those with perforated dura. In this connection it is astonishing to see the extent to which the dura can withstand destruction of the overlying bone, which may be completely comminuted over wide areas and yet without dural laceration, although the brain beneath may or may not be extensively destroyed.

Viewed from the combined clinical, anatomical and operative standpoints, the most significant classification of projectile cranial wounds in general seems to be:

1. Scalp wounds, without definite external signs of fracture of the skull.
2. Depressed fracture, without injury to the dura.
3. Fracture involving the dura, but without infection or lodgment of foreign bodies.
4. Fracture involving the dura, with infection and with foreign bodies in the brain.
5. Fractures and fissures of the cranial fossas, either complicating fracture of the vault or as the result of direct injury.

When the skull is fractured, the inner table suffers far more severely than the external. As a rule, and accordingly, every fracture of the skull, regardless of its apparent triviality, should be considered as associated with comminution and depression of the inner table and with the consequent damage to the dura, the meningeal vessels and the venous sinuses.

The immediate consequences of fracture of the vault are exemplified by concussion, compression and irritation of the brain. Patients with depressed

fractures are often, though not always, unconscious for a few moments immediately after the injury, but are often able to walk considerable distances within a short time. Headache, in all instances due to a pathological rise in intracranial pressure as the result of the traumatic edema of the bruised brain, is an almost constant and frequently distressing symptom which may demand one or repeated lumbar punctures for its relief.

Progressive hemorrhage is a condition of great rarity among cranial wounds in which the initial injury is survived, and when it does occur, its cause is not uncommonly found in the existence of fissures running to parts of the skull remote from the point of direct injury.

Very often the only sign of intracranial damage in these cases of projectile wounds is persistent injection of the optic discs, without swelling, and the exact nature of the damage is disclosed by an exploration or revision of the scalp wound, after the X-ray findings have corroborated the ophthalmoscopic evidence.

Both pulse and temperature curves are notoriously unreliable after cranial injuries. Early absence of frank fever is common in secondary brain abscesses, and on the other hand a pulse of normal rate may actually be a pressure pulse concealed by the toxic effects of complicating infection.

Every injury of the skull is, for a long time, a source of potential danger and the persistence of any sign or symptom, however trivial, is to be looked upon with suspicion. Further, persistent cranial fistula means the definite existence of a cranial or intracranial foreign body of some sort, which must be removed if possible, because of the danger, if not the certainty, of a late abscess of the brain, or meningeal infection.

Roberts (*Brit. Med. Jour.*, Oct. 2, 1915, p. 498), discussing latent grave injuries with apparently minor external wounds, states that "The number of patients who arrive at the base hospitals with bullet wounds of the scalp is large, but as their injuries are apparently superficial and their symptoms few or none they are frequently transported as 'sitting' cases and on arrival there is a tendency to overlook the fact that a fairly high percentage have definite lesions of the skull, or of the skull and brain."

Roberts' analysis of these lesions found at operation in 140 cases of this order demonstrates that any projectile wound of the scalp, however slight, should be subject to early exploration to determine the presence or absence of a fracture. The 140 cases included:

Scalp wounds only	82
Fracture of outer table only	19
Fracture of inner table only	1
Fracture of both tables, dura uninjured	18
Fracture of both tables, dura lacerated	1
Fracture with laceration of dura and brain	19

The excision of the scalp wound down to and including the pericranium, as practised by Roberts and many others as the first step in the exploration under novocain-adrenalin or general anesthesia, has to recommend it that:

1. The diagnosis of fracture is usually established with absolute certainty.
2. If no bone injury is found, the wound is sutured without drainage and heals by primary union in over 95 per cent. of the cases.
3. Time, trouble in attendance, and expense in dressings are saved.

Cushing (*Mil. Surgeon*, June, 1916, p. 601) expresses the present situation with regard to the treatment of cranial injuries: "There is no unanimity of opinion as to what should be the routine treatment of cranial wounds at first line hospitals. Some, owing to sorry experience, advocate leaving all except the minor injuries alone; some advise immediate trepanation only of the tangential wounds in which the dura has presumably escaped injury; but by

far the larger number, basing their views on the experiences of earlier wars, recommend the prompt treatment of every case at the earliest possible moment. The operation usually consists of enlarging the wound, the elevation of depressed fragments, the removal, so far as possible, of the spicules driven into the brain, and direct drainage."

Although approximately 55 per cent. of the cases of cerebral injury, operated on within a few hours after injury under the necessarily primitive conditions of the usual field hospital, die from meningo-encephalic infection and from the remote fatalities due to secondary complications months afterward, Cushing believes that "if a field hospital is perfectly equipped in personnel and X-ray apparatus, and a thorough neurologic study can be made, immediate operation may be desirable," but under any less ideal conditions he is deeply convinced that "the likelihood of ultimate perfect recovery is seriously lessened, if preliminary and necessarily incomplete measures are there undertaken." He further states: "I believe that though an immediate operation might save 1 or 2 per cent. which could not reach a suitable base, 10 or 20 per cent. could be spared the late sequels of these injuries if their primary operation. even with a delay of two or three days, could be done under ideal auspices."

Wilms recommends immediate removal of the indriven hair, bone and metal fragments and the crushed and softened brain in tangential shots, on the principle that early operation removes the foci of infection before the reactive edema becomes well established and lessens both the traumatic edema of the missile and operation by adequate drainage. Gray states that septic wounds of the scalp and skull are particularly easy to deal with by complete and early excision, and healing takes place by primary union, after suture, unless sepsis has obtained a firm hold in the lacerated brain. "Edema and so-called shock are no bar to operative success. Indeed, it seems likely that both pass more quickly the sooner and more thoroughly the foreign material is removed, pressure and edema due to the circulatory obstruction relieved and adequate drainage established."

Velter, after a year's experience with skull wounds seen within six hours following injury, is convinced that immediate operation in these, perhaps more than in any other wounds, is essential to a favorable outcome, for there is less chance of infection, less need of drainage and more opportunity for primary healing of the operative field. He believes that the mechanical disinfection of a wound within a few hours of its incidence, with the removal of foreign bodies and the excision of dead, disintegrated tissue, is nearly always sufficient to ensure secondary reunion.

Relative to the time of operation, the degree of shock, the hospital facilities and the type of surgical skill available and the necessity for more or less prompt transportation, are deciding factors. In general, the safest time for operation is from two to four days after the injury, when the patient has reached a permanent and well-equipped base hospital where X-ray examinations can be made and the scalp adequately prepared. Sargent and Holmes state that delay lessens the danger of infection of the subarachnoid space by allowing the formation of adhesions, and further lessens the danger of formation of hernia cerebri. Operative reactive inflammation, added to the traumatic edema already existing, increases the tendency of the brain matter to protrude, hernia cerebri, of course, being a symptom of abnormal intracranial pressure. "Further, the lining of the ventricular cavity tends to herniate, first into the overlying softened brain and then into the base of the hernia cerebri; ultimately it may rupture and discharge cerebrospinal fluid;" ventricular infection following rapidly. The formation of a cerebral hernia is therefore not only dangerous to life, but to the function of the protruded brain and of that

in the neighborhood of its base, the finer cortical and subcortical structures being unable to withstand the dragging strain placed upon them.

"The respective dangers, those of meningitis and of hernia formation, attendant upon early operations, and those of infective encephalitis due to retained, infected foreign bodies, and of ventricular infection, which beset delay, must be balanced against each other, experience seeming to show that the dangers of early operation are the greater."

As serious wounds of the skull have been overlooked by neglecting the complete clearing of the scalp of hair, this is the first step in the local preparation for operation. This is best and most quickly done by clipping the hair as close as possible with a clipper and applying a depilatory such as a fresh mixture of 2 parts of barium sulphide, 5 parts of starch and 1 part of orris root, made into the consistency of a thin paste with warm water, and rubbed well into the whole scalp. Within ten minutes the hair can be entirely scraped away with any dull instrument and the excess of paste removed by washing with water, the razor cuts so common to the usual shaving preparation being thereby avoided.

The scalp is best cleansed with alcohol and both scalp and wound thoroughly painted with strong tincture of iodine. In using a rubber tourniquet about the head to control bleeding, pressure upon the eyeballs should be avoided.

The first step of the exploration is the complete excision of the contused and septic scalp wound down to and including the pericranium. If no evidence of deeper injury is found either locally or symptomatically, the wound may be sutured at once and usually heals by primary union. If the skull is fractured, however, it is seldom necessary to trephine, but the fragments of bone may be carefully elevated and removed until room is created for the insertion of a rongeur, by which all soiled and depressed fragments are gently gnawed away until the gap in the skull is rounded off. There is positive danger in allowing free buttons or fragments of bone to remain over the dura, for later depression and epileptiform symptoms occur from such sources. Fissures should be rongeured up, especially if the dura beneath them is torn. Space for these more extensive manipulations is given by the creation and reflection downward of a broad flap, with its pedicle downward, in the middle of which is placed the original excised scalp wound, which is later closed by sliding a layer of aponeurosis over the defect.

Numerous observers have removed metallic foreign bodies, such as fragments of bullets and shrapnel, from the brain with a minimum of trauma by the use of a giant magnet and at times under direct Roentgen-ray control. Sargent and Holmes use soft iron rods, 12 to 18 cm. long and 1 to 1½ cm. in diameter. These are passed along the track of the missile after previously removing the fragments of bone under a stream of hot saline. At the desired distance the nose of the magnet is applied to the end of the rod and a current having a pulling strength equivalent to several pounds applied, this being enough to attract metal fragments an inch or more distant from the point of the rod. After a few seconds, during which the click of an attracted foreign body may be heard or felt, the apparatus is gently withdrawn and, by turning off the current, the attached foreign body is dropped into a sterile test tube for cultural purposes.

Where thorough cleansing of the wound has been possible and the existence of sepsis does not gainsay, the denuded dura or brain is covered and protected by scalp, or by sliding a pericranio-aponeurotic flap after the ingenious manner devised by Sargent (*Brit. Jour. of Surg.*, Jan. 1, 1916), the wound being drained at its angles by rubber tubes, or better by rubber tissue wicks, carried down to but not into the bone defect.

Drainage is indicated in the presence of pus, of infected blood-clot, of definitely infected but inaccessible foreign bodies and where there is free oozing from an extensive laceration of the brain. A gauze drain is never justifiable in wounds of the brain because of the certainty and the density of the adhesions which result. Small, fenestrated rubber tubing, or preferably rubber tissue wicks, give the best drainage, while the latter are most efficacious and have the least possible effect as a foreign body. Sargent and Holmes use glycerin in the lumen of the drainage tubes for its hygroscopic effect, its inhibiting action upon the growth of pyogenic cocci, and its apparent effect in emulsifying disintegrated brain and thus aiding its escape. The drainage tubes are surrounded by gauze soaked in glycerin and a large dressing of gauze and wool applied. If afterward reactive edema tends to extrude the tube, lumbar puncture is done.

Perforating wounds of the skull in which immediate death has been escaped usually recover without operation, although in some of the more severe cases it is necessary to trephine both the wound of entry and that of exit, where wide fissures and extensive contusion of the brain may exist.

Fractures of the base of the skull from direct projectile injury are seldom operable and must be treated expectantly or, upon the signs of beginning infection, suboccipital decompression and drainage of the subarachnoid space may be done, according to the method of Cushing.

Lumbar puncture is one of the most valuable aids in the diagnosis and treatment of projectile injuries of the skull. By the character of its cellular, and the amount of its albuminous content, the spinal fluid gives important information as to the extent and severity of the injury, and by its immediate effect in reducing the intracranial pressure, the operation often gives prompt relief to the severe and continuous headache, to the paralytic phenomena, melancholia, stupor or even to the epileptiform attacks which not infrequently follow simple contusion of the skull, and concussion, without focal injury of any sort. In simple concussion and in most non-penetrating wounds of the skull it is the only rational treatment. Fifteen to 45 c. c. may be withdrawn daily, as indicated, and the procedure, even repeated in this way, seems harmless unless the pressure in the fluid is below normal to start with. The optic neuritis, so constantly associated with all these forms of intracranial pressure, is benefited in proportion with other symptomatic improvement.

In air concussion the intracranial pressure often remains high for days after the injury, and these cases appear to suffer almost none of the consequences of lumbar puncture seen in civil life when done for diagnostic purposes or for the relief of diseased conditions.

Lumbar puncture is also of particular value in penetrating wounds, where it lessens the tendency to the formation of cerebral hernia and aids in its control, if already developed. If done before the subarachnoid space about the wound has become closed by adhesions, it must be used with care lest it be the means of introducing meningeal infection, which may also result from withdrawing too much fluid, thus causing the brain to sink back from the dura and tearing the adhesions. Medullary strangulation in the foramen magnum has also resulted from excessive withdrawal of fluid. The diagnosis of rupture into, and of infection of, the lateral ventricle also may be aided by examination of the spinal fluid.

Where lumbar puncture fails to relieve increasing pressure symptoms, a contra-lateral subtemporal decompression may be indicated.

As a further aid, the use of urotropin in doses of 1.0 to 2.0 grams every three or four hours is indicated in every projectile injury of the skull with accompanying fracture, and is to be continued until danger of immediate

infection is past. Bromides in full doses are necessary for months after every cerebral injury.

Helmets. The degree of prevention of cranio-ocular injuries which may be effected by metal helmets of the type adopted by the French, later modified by the Belgians, English and Germans, still remains to be determined. They seem to be highly effectual against schrapnel, spent projectiles and the multitude of fine secondary missiles which so frequently and disastrously involve the eyes; and the overhanging brim protects both the eyes and the occipital region. The frequency of minor wounds and contusions still is increased, but helmets apparently reduce the proportion of severe or fatal cases.

FACE INJURIES

It is remarkable that the eyes, whose combined surface is only about $\frac{1}{375}$ of the surface of the body, should be involved in approximately 8 per cent. of all injuries, but the explanation lies in the constant exposure of the head, and especially the eyes, in trench warfare; in the fact that the eyes are so frequently injured by fine particles which would have no deleterious effects elsewhere in the body; and in the great frequency of symptomatic involvement as a consequence of remote lesions.

Naturally, the less imperative measures, such as the routine radiographic examination, the more complicated cases of intraocular foreign bodies and extensive plastic operations on the orbit and lids, are preferably done in the reserve or civil hospitals, but provision for the adequate first-aid treatment for these and for all eye wounds soon after injury and while en route to the rear is a matter of such consequence in preserving vision and in preventing infection, that a knowledge of its essentials should be spread among civilian surgeons suddenly called to active military duty, and among professional military surgeons as well, by means of special instructions. A comprehensive summary of such instructions follows: (Mills)

First aid in battle wounds of the eyes.

1. Before cleansing or manipulating a recently injured, sensitive eye, lightly anesthetize it with from 2 to 3 drops of 4 per cent. solution of cocaine, instilled at 3 minute intervals.
2. Cleanse the skin of the lids and the adjacent field by gently washing with soap and water, followed by benzene (benzol).
3. Cleanse the conjunctival sac of loose foreign material by free irrigation with warm 3 per cent. solution of boric acid, warm normal saline or warm 1/10,000 bichloride or oxycyanate of mercury, whichever may be available, not forgetting that strong antiseptics may seriously damage the cornea.
4. Where foreign bodies are deeply imbedded in the cornea and where the whole cornea and conjunctiva is tattooed with indriven mud, fragments of stone or metal, the dangers of corneal perforation and infection are so great that such cases should be hurried to the nearest specialist center.
5. A wound of the eyeball, the gray-white change of a traumatic cataract and effused blood in the anterior chamber, usually mean perforation of the eye by a foreign body. These cases demand the earliest possible specialized care and should be given precedence of way to the rear.

The chances of infection of the globe through the open wound are so greatly lessened by promptly covering the wound with a flap of conjunctiva that more eyes can be saved and more practical vision retained in such eyes by this than by any other single procedure. With corneal wounds a sufficient amount of adjacent conjunctiva is undermined and drawn down and held in place over the opening by simple conjunctival sutures of fine silk at each angle. If the laceration is considerable, but there are possibilities that some vision

may be retained, the entire cornea may be thus covered and protected by undermining the conjunctiva throughout the whole circumference of the cornea and uniting it over the front of the globe.

6. Both eyes should be put at rest by full dilation of the pupils with 1 per cent. atropine, a matter of much importance during rough transportation, and, unless contraindicated, both eyes should be lightly bandaged, using gauze, cotton and bandage material from within outwards. In a few cases if tension of the eye, determined by palpating the globe between the index fingers, is high, and in this condition instillations of a 1 per cent. solution of eserine are indicated, instead of atropine, until the pupil is very small.

SHELL WOUND OF THE LOWER JAW.

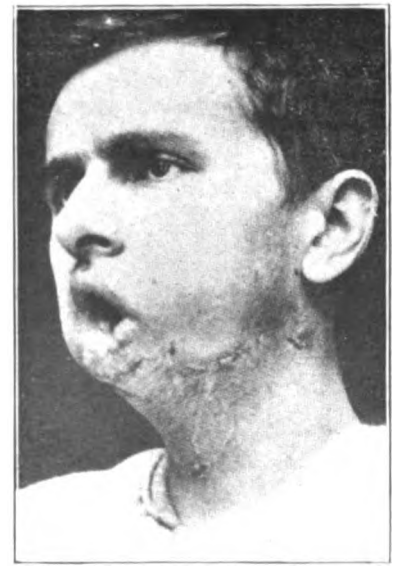
ACTUAL SIZE OF FRAGMENT OF HIGH-EXPLOSIVE SHELL REMOVED FROM LOWER JAW OF PREVIOUS CASE.

7. Eyes which are suppurating from any cause should not be bandaged, but are to be washed out freely and frequently. Extension of the infection to the sound eye and to the eyes of others is to be guarded against.

8. Unless an eye is completely shattered, too early enucleation is not to be counseled. Sympathetic inflammation of the sound eye is almost unknown inside of two weeks after injury, and many eyes are blinded for the time

A.

B.



C.

OPERATIVE STAGES SHOWN IN A SERIES OF THREE PHOTOGRAPHS OF THE SAME CASE. SHRAPNEL WOUND OF THE FACE AND JAW.

being by intraocular hemorrhage which may clear in a few weeks or months and leave more or less useful vision. The decision in this matter of such importance is best made at the specialist center.

9. Inflamed and tender eyes with failing vision or without vision are best enucleated at once, because of the danger of sympathetic inflammation of the sound eye. The conjunctiva and the ocular muscles are spared as much as possible in order to form the best possible socket for an artificial eye.

10. Eyes that have been shattered are to be enucleated at once, with particular care to remove all fragments of bone, which are so commonly driven deeper into the orbital fat. By early operation, excessive cicatricial contraction is avoided and a far better bed formed for an artificial eye.

11. Fragments of missiles lodged in the orbital tissues are harmless, especially if they produce no evidence of irritation.

12. Defects in the lids should be repaired at once, lest cicatricial contraction make a good operative result difficult or impossible to obtain.

13. Wounds of the eyes and orbit are no exceptions to the routine employment of antitetanic serum in military wounds.

14. The routine use of narcotics in injuries of the eyes is to be deplored, in view of the possibility of habituation. Small doses of paregoric or tincture of opium are usually sufficient.

15. The inclusion in the medical equipment of a focusing lens, a self-retaining lid retractor, an instrument for removing foreign bodies from the cornea, and of atropine, eserine and cocaine in the form of salts or solutions is essential for the adequate care of battle injuries of the eyes.

Face and jaws. Some of the most mutilating and horrible results of modern warfare are seen in battle wounds of the face and jaws. Such wounds range in severity from simple perforations of the cheek to destructions of from one-half to two-thirds of the entire face. Great difficulties often arise due to the fact that the man must breathe and receive nourishment through some portion of the wound, and so an injury of these parts not infected is never seen.

The primary treatment of shell wounds of the face and jaws resolves itself into the control of hemorrhage, removal of foreign bodies and shattered small bones, and application of Dakin's solution by the irrigation of the dressing method. After the infection has cleared and there are healthy granulations formed, it is time to do a plastic operation for the proper closure of the wound. This type of reconstructive or plastic surgery is one of the most difficult in military surgery, and it is for this reason that plastic operations upon the face and jaws are referred to men having a special adaptability for such work.

GUNSHOT WOUNDS OF THE CHEST

One of the most striking features of a modern military hospital is the large number of penetrating gunshot wounds of the chest admitted with comparatively trivial symptoms. The immediate results following such injuries are often marked and severe, but those patients who survive and are sent to a base hospital are often surprisingly well when first admitted. The experience of military surgeons in the present campaign serves to confirm the observations made in the South African War, viz., that the modern high velocity, hard-jacketed rifle bullet can pass through almost any part of the lung, and sometimes even through the heart, without death of the patient resulting.

It is impossible to calculate with any degree of accuracy how many cases of gunshot wounds of the chest die on the field of battle from injury to the heart or large vessels, but it would seem that even extensive wounds of the

lung and chest wall may be recovered from. The actual site of penetration of the chest is undoubtedly of importance, as many with injuries to the root of the lungs and large vessels, die soon after injury; but in those that recover sufficiently to be removed to a base hospital, injuries are met with in every conceivable portion of the chest, and recovery is little affected by the site of the wound.

A very noticeable feature in cases of gunshot wounds of the chest is the rapid recovery where there is no destruction of the chest wall, compared with the high mortality in cases with an open wound on arrival at the base. Cases where a wound in the chest opens into the pleural cavity, with communication between that cavity and the outer air, are almost uniformly fatal.

Captain J. L. Menzies at Alexandria has recently made a study of 75 cases of injuries to the chest and a summary of his results follow:

The primary symptoms, in the order of frequency, are pain, shock, dyspnea and hemoptysis, all of which occur at the time of injury, or soon after.

Pain is rarely very severe and calls for little comment. Shock may be severe, at times resulting in loss of consciousness, but a few of the men are able to walk after the injury. Dyspnea is almost always present at the time of the injury, and is generally characteristic. Among 75 cases, only 12 gave no history of dyspnea. In 48 cases there was hemoptysis, 40 immediate and 8 delayed. The temperature is said to be elevated in all cases after chest injury. After admission to the base hospital, the predominant symptoms are dyspnea and pyrexia.

Of the 75 cases admitted to the hospital, 56 were wounded by rifle bullets and 19 by shrapnel or bombs. The latter wounds were more severe, as a rule. A large proportion of projectiles were retained in the chest. This was the case on admission in 35 instances—26 bullets and 9 pieces of shrapnel: 4 rifle and 4 shrapnel bullets were extracted from the chest wall or pleural cavity, and 27 patients were discharged from hospital with the projectile still retained and apparently causing no symptoms. The presence or absence of the missile seems to make little difference to recovery.

Treatment. All cases of perforating wounds of the chest must be carefully watched from the time of injury. The immediate symptoms generally improve when the patient is kept quiet. Hemoptysis ceases spontaneously in nearly all cases. At the time of injury, morphine may be given and any bleeding from intercostal arteries should be arrested; but, as a rule, no further treatment is necessary beyond keeping the patient quiet. On admission to hospital, when there is no effusion into the pleural cavity, no special treatment is necessary, and recovery is rapid.

When effusion is present, the chest should be explored at an early date and the fluid examined bacteriologically. When the fluid is found to be sterile it may or may not be aspirated: In cases where the effusion is large, with marked dyspnea and much displacement of the mediastinum, it is always advisable to aspirate the fluid; when the effusion is not large, it may be aspirated or left alone.

When definite pus is present, the pleural cavity should be drained at the earliest possible time by the resection of ribs. In old pleural cavities following drainage, irrigation with Dakin's solution is indicated. The majority of cases occasion no anxiety from the time of admission; their recovery is uninterrupted, although signs of fluid may be present for a long time after the patients are apparently well. It is beneficial to get them up early, even before the temperature is quite normal, and to practice gentle exercises and breathing exercises.

WOUNDS OF THE ABDOMEN

In the early months of the war, penetrating wounds of the abdomen were usually treated on an expectant plan, but it was soon demonstrated that most penetrating wounds of the abdomen should be operated upon early. Webb and Milligan give an interesting description of cases seen during the first year of the war, of which a summary follows:

"1. We believe it advisable not to operate at sight and on principle on every case of suspected penetrating wound of the abdomen, but to make as definite a diagnosis as is possible before deciding whether to operate or not.

"2. We think it advisable to wait a certain time after the case has been admitted, for the following reasons:

"a. To combat shock.

"b. To distinguish between moribund cases and those that rally with 'anti-shock' measures.

"c. To endeavor to distinguish cases requiring operation from those likely to recover without operation,—i. e., that group of cases which rally with anti-shock measures.

"3. It is essential to operate in every case that rallies well, where, after due consideration, we believe a hollow viscus to have been wounded, or where we have reason to suppose that progressive hemorrhage is taking place.

"4. It is useless to operate in bad cases that do not respond to preoperative shock therapeusis.

"5. We do not think it advisable at present to operate in a casualty clearing station on cases in which we have reason to believe solid organs alone are injured, and in which there are no signs of continued hemorrhage.

"6. During operation it is of the utmost importance to follow a rigid routine method of examination of the abdominal contents, keeping in one's mind as far as possible the track of the wound.

"Minor points are:

"a. To make a complete and detailed estimate of the number and character of all the lesions wrought by the projectile before attempting any remedial measures.

"b. The performance of one resection of gut where possible rather than multiple sutures.

"c. Not to place sutures in devitalized tissues.

"d. A careful search for the missile.

"e. Completeness of operation, especially thorough closure of the inevitably large laparotomy wound. We suture the abdominal wall in layers.

"7. Post-operative shock is never negligible and in most cases is almost certain to be the most dangerous complication to be feared after the case has left the table."

The expectant treatment of abdominal injuries was the method of choice in the armies of all the combatants at the beginning of the war. Gradually on every side the operative has replaced the older method. Although it is very difficult to compare the two methods, some interest attaches to the figures obtained in the two periods respectively. The figures in the preoperative period have to be taken from the admission and discharge books of the field ambulances and casualty clearing stations, as no special books were kept; consequently the figures could only be computed. In the second period, special books were used and the figures may be taken as approximately correct.

Cuthbert Wallace reports that into nine field ambulances over a period of six months, there were admitted 1,098 abdominal wounds, with 333 deaths,—a mortality of 30 per cent. In the six casualty clearing stations during the

same period there were admitted 131 cases of perforated abdominal wounds, with 73 deaths. From these figures it appears that the total mortality in the field ambulances and clearing stations was about 70 per cent. There were also the deaths at the base in France to be added, and the preoperative period to which we now allude. Many such deaths occurred which would, as far as can be judged, bring the mortality up to about 80 per cent. As showing the difficulty of arriving at accurate figures, it was stated by some that 80 per cent. of abdominal wounds recovered.

General incidence of wounds. The charts were made by plotting the entrance wounds on the front and back of the body respectively. The wounds of the back form a substantial proportion of the whole. There is a tendency for the wounds to collect towards the sides, especially on the back of the body.

The comparative absence of mid-line wounds is also seen, which represents the wounds in cases too bad for operation when they reach a casualty clearing station. This distribution is brought about by the presence in the mid-line of the spine and great vessels. Men shot in these situations die on the battlefield. The collection of wounds towards the sides of the body may also be caused by the fact that a man's front and back are more or less protected in the trench, while the sides of the body are opened to enfilade. Many of the wounds of the back, especially those of the buttock and thigh, are due to bombs and rifle grenades, a man instinctively turning his back to such a projectile in attempting to get away from it.

The posterior wounds show a larger proportion of deaths than the anterior. In nearly every case there was much blood in the abdomen, and in 13 cases the note was made that death was due to hemorrhage. In only 5 cases was shock noted as the cause of death: (1) Perforation of ileum with a shattered os ilium; (2) Multiple wounds of small gut; no blood in belly; (3) Shock; no other details; (4) Wound of ileum and sigmoid; peritonitis and shock; (5) Wound of rectum and small gut. In one case retroperitoneal sepsis was noted as the cause of death. In only three instances was peritonitis deemed the cause of death. The number of times the small gut was injured is the salient feature in the series, and perhaps another interesting point is the fact that the stomach figures five times. Wounds of the solid organs were responsible for death in twelve instances.

In the chart are a good many buttock wounds. From experience gained in operating upon such cases, we must regard lesions of the pelvic vessels as a frequent cause of death.

Some curious instances of side-to-side wounds may be of interest: (1) A wound of the upper pole of the left kidney and lower pole of the right, wound of ascending colon, paraplegia; fatal. (2) Wound of the right kidney and spleen; vertebra penetrated; no paraplegia; fatal from splenic hemorrhage. (3) Spleen torn to its anterior edge, left kidney perforated through its center, upper pole of right kidney destroyed; fatal, (bullet). (4) Wound of the left kidney and the posterior surface of the ascending colon; fatal.

Cases recovering without operation. The accompanying figure was obtained by plotting the entrance wound, the track of the bullet when known in cases that recovered without operation. Most of these wounds lie within the liver area. The chart also shows wounds in various other parts of the abdomen, and the explanation of their recovery is most probably due to the fact that the hollow viscera had escaped, although the abdomen had been penetrated.

Epigastric wounds are usually accounted as stomach wounds and recovery is often recorded as an instance of spontaneous healing. Operation has proved that in some cases the projectile leaves the stomach and perforates the gastrohepatic omentum. Naturally, wounds in this region will often involve both

surfaces of the stomach. Epigastric wounds have not maintained their reputation as favorable lesions.

As in civil life, one meets with a fair number of abdominal injuries caused by horse kicks. Others are caused by falling-in of dug-outs, by burial of men by shell explosions, and by blows of fragments of wood which are hurled about. They present nothing out of the common, and the injuries seen are the same as some in civil life.

Comparative frequency of wounds in different viscera. The following table, quoted by Wallace, gives some idea of the relative frequency with which different organs in the abdomen are wounded. The total number of cases from which the table was made was 965.

Viscus	No. of wounds	Viscus	No. of wounds
Stomach	82	Kidney	73
Small gut	363	Bladder	45
Colon	252	Pancreas	5
Liver	163	Spleen	54

General lines of treatment. "Accumulative experience shows the wisdom of operation as a rule. It is now mainly a question of excluding a few cases on which it is best not to operate. It can be frankly admitted that this line of treatment involves operating upon some patients who would have got well without. It also involves operating on a certain number of cases where there is bleeding without visceral injury, which also might have recovered without. On the whole, it may be said that the policy of 'look and see' is better than one of 'wait and see.'

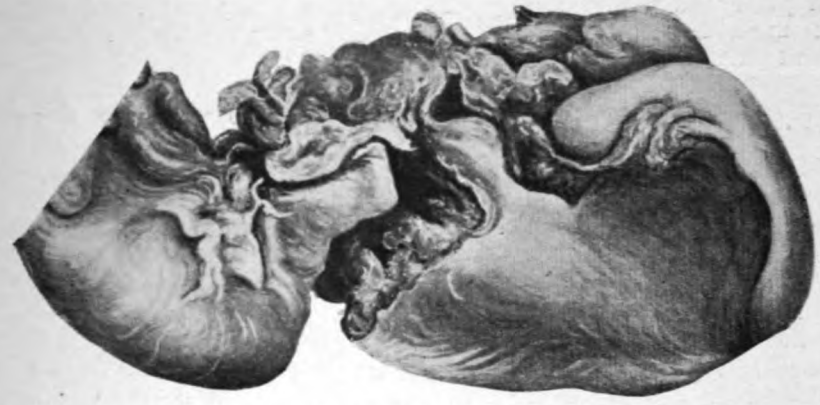
"It may be useful to enumerate those cases which were best left alone.

"1. *Cases in very bad condition.* There are, of course, many cases which no surgeon would feel himself justified in operating on; but there are many border-line cases which some surgeons would leave and others would feel constrained to give the chances of operation to. Here the personal equation comes in, and whether he operates or not must be left to the surgeon to decide. Here again the pulse will be a valuable guide. The bolder surgeon will get the worse operative mortalities.

"2. *Cases shot high up in the abdomen in the liver area.* Such cases on the whole do very well if left alone, so long as there are no symptoms of hemorrhage,—in fact, hemorrhage is the only reason for operating upon liver cases or those involving any solid organ. It is, of course, true that a certain number of cases succumb to sepsis at the base, but their number is not sufficiently great to warrant early interference on that account.

"3. *High abdomino-thoracic wounds on the left side.* The type of wound more especially referred to is that which enters somewhere near the mid-line behind and emerges somewhere towards the posterior part of the axilla about the level of the sixth to the eighth rib. These wounds are sometimes accompanied by symptoms suggesting stomach involvement, but on the whole do not seem to do so badly; and operative interference does not afford very much help, as wounds high up in the cardia or near the esophagus are almost impossible to close, or, if they can be reached, involve such disturbances as are likely to lead to a fatal result.

"4. *Cases arriving late.* I am inclined to put down twenty-four hours as a usual limit within which a primary operation is likely to be successful: hemorrhage by this time has ceased, and operation is only likely to spread infection if the bowel has been perforated, and to hasten the end. There are some cases in which operation may be thought advisable, namely those with



LACERATED BULLET WOUND OF SPLEEN.

BULLET WOUNDS OF SMALL INTESTINE.

a fair pulse, but with vomiting; the operation being performed with the idea of getting over the obstruction by short-circuiting or an enterostomy. Operations of this class have nearly all been fatal."

GUNSHOT FRACTURES

Due to the unusually high velocity of the missiles used in the present war, fractures are very common. Besides, these fractures are nearly all comminuted and are all infected. These facts constitute a serious problem to solve on the battlefield.

Compound fractures are practically always accompanied by other wounds in other portions of the body, and often by an intense degree of shock. Particles of clothing are usually carried into the wound by the bullet or shell fragment. The great difference between civil and military surgery of fractures is in the accompanying comminution and great destruction of the soft parts in the latter cases.

The treatment of fractures resolves itself into:

1. Treatment of shock.
2. Treatment of infection.
3. Removal of foreign bodies and entirely loose splinters of bone.
4. Immobilization of the limb.
5. Extension of the broken bone, sufficient to secure correct alignment and full length.
6. Semiflexion of the joints above and below the broken bone, to relieve the tension of the flexors and to place the limb in a position of physiological rest.

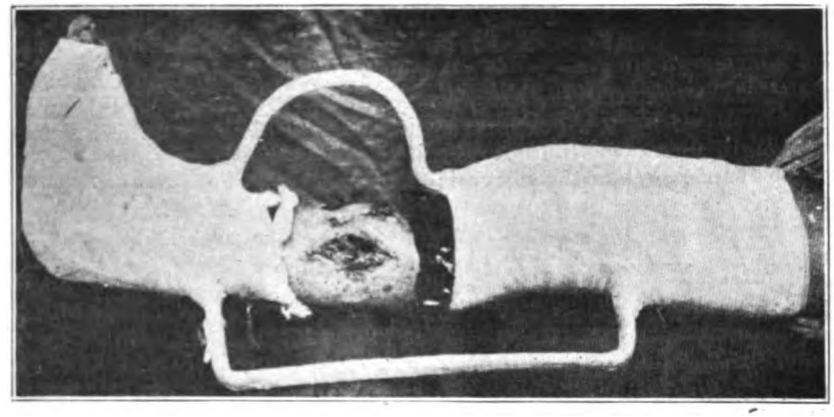
The injured portion of the limb must be kept at rest. The difficulty arises in carrying out immobilization and extension without hindering the treatment of the wound. Dressing without movement is an important point in the treatment of gunshot fractures, especially in the leg, because the weight of the lower limb causes great displacement to occur when it is raised for dressing.

Extension methods. The use of Buck's extension by means of adhesive strips is usually not possible because of the presence of the wound. When it can be used, however, it is an excellent means of extension.

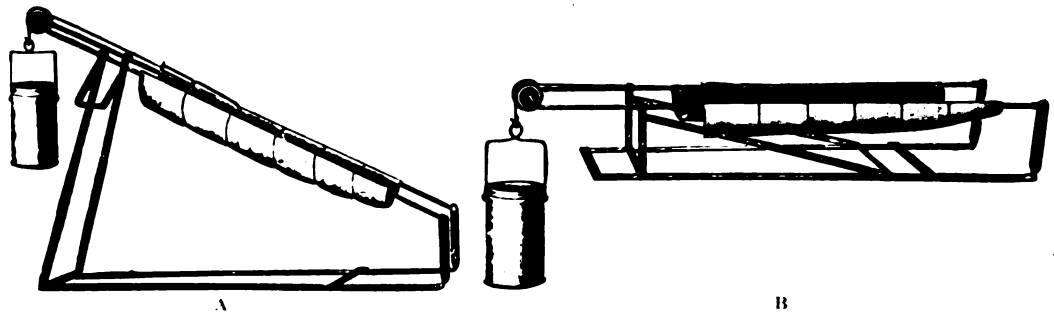
For the leg, metal skeleton splints have proved the most useful; the Thomas and Page splints at present being most used. All alike aim at a bearing on the tuber ischii and the pelvis, and a steadying of the fracture by extension. They have been of great service and are far the best form of apparatus for use near the front, and for conveyance in ambulances and trains. The Balkan suspension splint is also a good form to use, especially in the later treatment, as the patient can help himself to a great extent.

The treatment of the arm is comparatively much simpler, because the weight of the member can be used as a means of extension with the man in an upright position. With the added weight of a plaster cast, a Kramer woven-wire splint, or the much superior open heavy wire splint of Thomas, Eiselsberg or Englemann, the last three allowing free access to the wound, there develops traction from the gravity pull alone.

There is a great temptation to use plates, screws and wire, but it is doubtful whether this is good practice in compound fractures. It will take a good deal of evidence to show that internal splinting is to be accepted as a principle in the treatment of gunshot injuries.



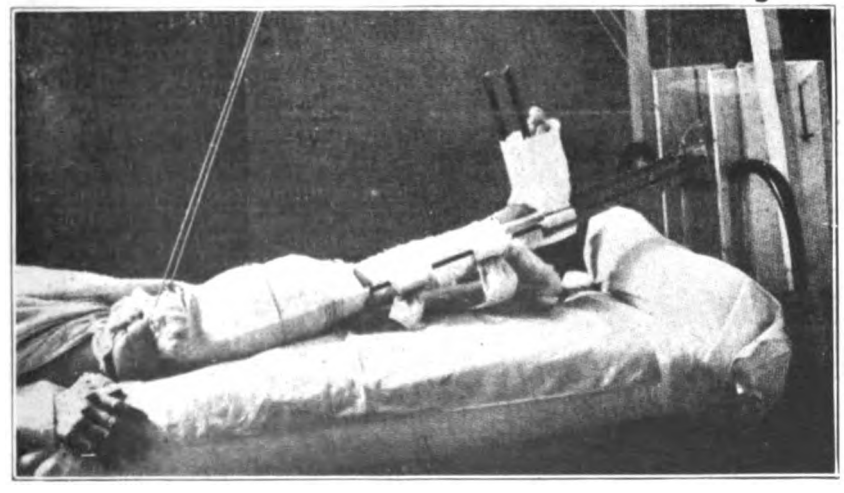
METHOD OF TREATING COMPOUND FRACTURE OF THE LEG BY AN INTERRUPTED PLASTER CAST.



A B

THE HINGED CRADLE SPLINT.

(a) Raised on the strut, as for dressing, (b) Horizontal position.



BLAKE'S SPLINT APPLIED TO A COMPOUND FRACTURE OF THE MIDDLE THIRD OF THE FEMUR.

The splint is made entirely of metal and is practically in two pieces. It is about eleven inches wide at the top and four inches between the bars at the bottom, easily adjusted to a large or a small thigh. The patient being placed in bed, after applying the first careful dressing, the splint is suspended as shown, and a ten-pound traction applied. The splint is comfortable and allows dressing as required.

NERVE INJURIES

There is a relatively greater proportion of nerve injuries in modern warfare, and the subject has become one of great importance in diagnosis and treatment. The reason for a greater incidence is probably in the larger number of gunshot injuries due to high velocity bullets that cause complete rupture of the nerve trunk. When the nerve is traversed in an acute angle to its long axis there is a correspondingly greater involvement. Particles from shells or bullets or secondary missiles may become imbedded in the substance of the nerve, causing, besides the palsy, unbearable neuritic pains. A scar developing about a nerve may cause a secondary paralysis, the nerve having escaped the bullet.

Diagnosis. The diagnosis of the actual injury which a nerve has sustained is very difficult, and in a large number of cases impossible, especially in the differential diagnosis of contusion, partial severing and complete break in continuity of a nerve trunk, for a reaction of degeneration is apt to be present in all three conditions. However, there are certain signs that indicate nerve injury, the most important of which follow:

1. Muscular wasting as compared with the opposite limb.
2. Abnormal limitation of mobility of joints.
3. Tenderness along the nerve trunks.
4. The reaction of degeneration.
5. Loss of epicritic and protopathic sensibility.

The nerves most frequently affected are the ulnar, musculo-spiral and branches, and the great sciatic and its branches. Then follow in order of frequency the median, brachial plexus, internal cutaneous, musculo-cutaneous, and cauda equina.

Treatment. According to Ranvier, Cajal and others, it is known that restitution of the nerve is possible only when the central end can send out new fibers to meet the peripheral stump. The central ganglia cells push out new nerve fibers as long as there is no resistance, such as scar tissue, to deflect the new nerve fibers. The nerve is regenerated by those fibers which reach the cells of Schwann, left over in the peripheral degenerated nerve. From these histological facts, two operative indications are deducted (Edinger), (a) to remove the resistance as thoroughly as possible, and (b) to pave the way for the new fibers to reach the peripheral stump.

Methods of operation. In fresh wounds, uninfected, and with injuries to nerves, it is best to suture the ends at once, where possible, with the finest silk or catgut. As present war wounds are usually infected, this procedure can rarely be instituted. The usual case is that in which more or less extra- or intra-neural scar tissue is present. This scar tissue must be very carefully dissected away and a good bed, preferably of fascia, provided.

After the resection of the scar tissue, there may be such a distance between the two stumps that primary suture is impossible. In such cases it is necessary to do a neuroplasty, or to graft the upper and lower ends into an adjacent nerve trunk. This method has proved successful in a number of reported instances, although failures are also recorded.

PART XII

THE SURGICAL HOSPITAL

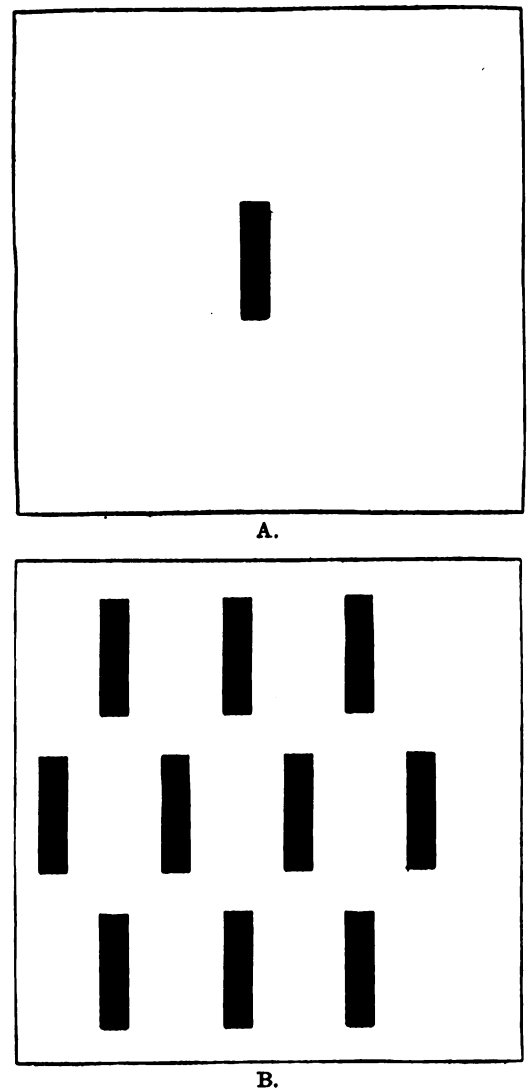
In order to do surgical work successfully, it is necessary for the surgeon to be able to secure for his patients proper hospital care. An artisan doing his work by going from house to house cannot compete with another who does the same class of work in a well equipped workshop, and the latter will again do better work in his own shop than he would in any other in which he might execute one piece of work. The surgeon of average ability and experience will usually do much better work in his own hospital, with his own assistants and nurses, than can be done by another, for instance, of much greater skill in a hospital in which neither the nurses nor the assistants are thoroughly familiar with his methods and technique. For these leading reasons, and many others which, however, refer more particularly to personal comfort, professional reputation and financial success, every surgeon should have a hospital, or a definite portion of a hospital, in which he can pursue his work systematically and after some definite plan that is in keeping with his technical ability, and which will enable him to perform the immediate work he has to do in the best possible way, and also enable him to make such progress from year to year as is possible under the conditions surrounding. Only the progressive surgeon can continue to prosper under existing conditions of competition.

In planning a surgical hospital, or a surgical department of a general hospital, it is important to secure primarily the greatest possible facility for caring for patients. Facilities which will give the patient the best obtainable conditions for a rapid recovery, combined with the greatest possible comfort while in the hospital. At the same time it is important to keep the cost of construction as low as consistent with securing the above. In doing this, however, it is important always to bear in mind that the running expenses of a hospital amount to as much every three to five years as the original cost of the buildings, hence it is of the greatest importance to plan construction so as to insure economy in the running expenses of the institution. In this manner a given amount of money will readily produce much greater advantage if the plans are properly made than if little or no attention is given to these important features.

It should be stated here that it is always wise to secure expert advice in the construction of hospitals. No one would think of employing an oculist to remove a stone from the ureter, or to make a gastro-enterostomy, and still it would be quite as reasonable to do this as for a surgeon who has had no experience in constructing a hospital to make his own plans, or to entrust this to an architect who has never made a special study of hospital construction, but rather has given his entire attention to the building of residences, stores or manufacturing plants.

It is advisable for the surgeon to make his own outlines, according to arangements he has seen in other hospitals, then to have a local architect make preliminary drawings. Then he should employ the best available architect who has made a special study of hospital construction and they together should

thoroughly revise such plans. Then the local architect should carefully complete these drawings, but before these are turned over to the builder they should again be corrected in every detail by the specialist in hospital archi-

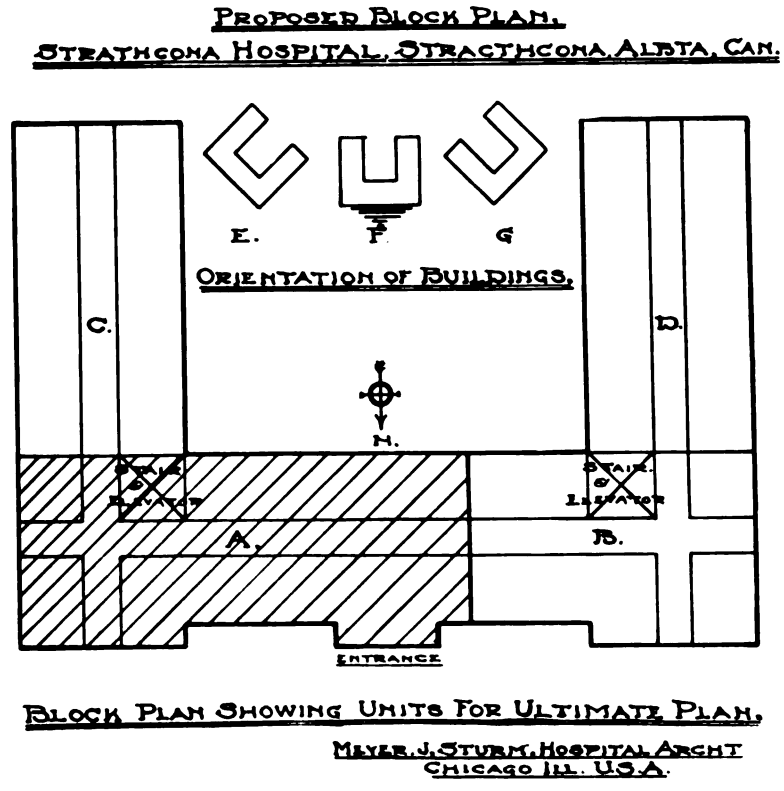


A. shows the amount of space occupied by a ten-story building in the middle of a ten-acre lot, extending from north to south, so that all the rooms have either east or west sunlight and the hall has sunlight from the south. Such a building would supply almost dustless air in almost any location if shrubbery and trees were planted along the edges of the lot. It would be much more sanitary than if the same number of patients were housed in ten one-story buildings, as shown in B., and the cost of construction and maintenance would be very much less in the former than in the latter.

tecture. We have repeatedly seen this course followed with the result of saving from twenty to fifty per cent. in cost of construction, an equal increase in efficiency and consequent reduction in cost of maintenance for the entire time that the hospital is in use after its completion.

During the past few years hundreds upon hundreds of new hospitals have been constructed in the various American cities and towns, and it is an interesting fact that in almost every instance these structures have been planned by people who had previously given the subject of hospital construction and location little if any attention.

Architecture. A local committee usually employs a local architect who consults the essays on hospital construction prepared nearly forty years ago by the authorities of Johns Hopkins Hospital. (*Hospital Construction and*



The shaded lines show the portion first constructed.

If this building is placed in the position shown in E or G, every portion of every outside wall will be covered with sunlight at some time of the day; if placed as at F, the entire north side of the building is not exposed to sunlight at any time of day. It is possible to overcome this objection by placing the utilities, like elevators, bath-rooms and service-rooms, in this part of the building and leaving the remaining portions for rooms and wards for the patients.

Organization, Baltimore, 1875). He may even go so far as to visit a few of the existing hospitals nearby, chiefly for the inspection of apparatus and operating rooms. He may also get the advice of one or more physicians who have never given the slightest attention to hospital construction, and with this preliminary preparation the building is planned and completed.

The result will depend largely upon the special line in which the architect has been active. If he has been in the habit of specializing in the planning of cottages his hospital plans will contain the characteristics of a cottage; if he has mostly built flat or apartment buildings their special features will be con-

tained in the plans and so on through the entire list of architectural specialties from the construction of grain elevators to churches.

In making an investigation concerning the construction of hospitals in the U. S., Bertrand E. Taylor (*Brickbuilder,* March, 1904), found that a vast majority of all hospitals at the present time were originally constructed for some other purpose, old buildings having been adapted. He also states that the new hospitals have generally been designed by architects of brilliant attainments, but who were generally totally unfamiliar with even the rudiments of hospital requirements.

The excellent work of Henry C. Burdett (*Hospitals and Asylums of the World,* London, 1893) is sometimes consulted, but this again simply repeats the ideas which were laid down in the essays just mentioned. The same is true if the various German books and pamphlets are consulted, for in all of these practically the plan of the Hamburg Hospital at Eppendorf is taken as the best type, and this was completed twenty-five years ago, and planned long before that time.

So thoroughly have these ideas taken root that in many instances enormous sums of money have been spent with the result that all of the patients are compelled to exist near the ground, where the air is least wholesome, most thoroughly laden with dampness of the soil and with street dust. Moreover, the amount of sunlight is greatly interfered with, because so large a proportion of the available land is either directly covered with buildings or is in the shadow of the large number of small buildings required to house the patients.

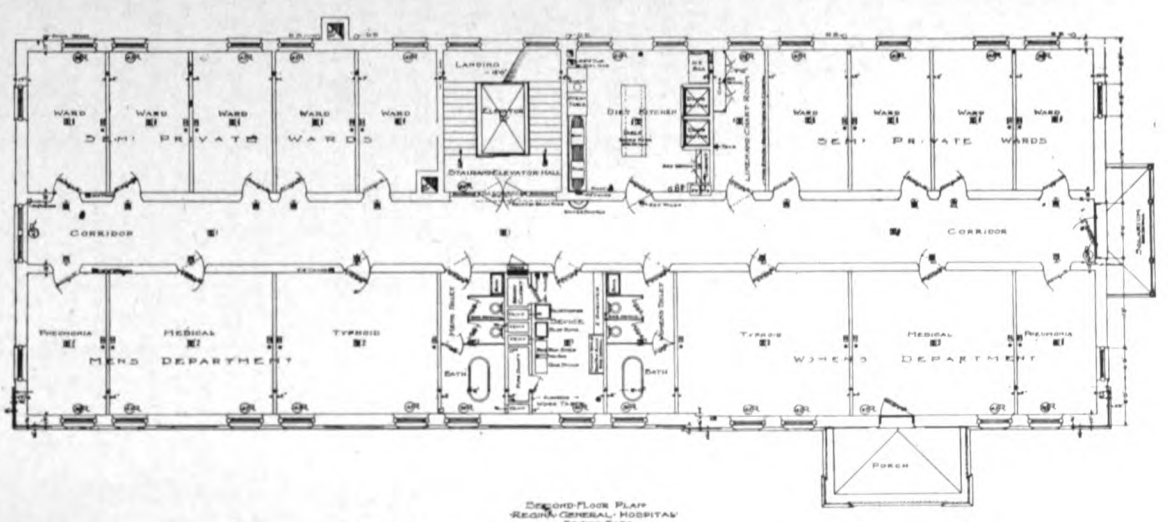
We refer, of course, to the plan of building a large number of one, or one and a half story pavilions, which has of late become especially popular.

As an example we may take the new hospital for the city of Vienna. That city is notoriously dusty. The authorities have constructed thirty-two separate, low buildings which will cover a great portion of the available ground. It is necessary to place some of these buildings relatively near the surrounding streets, thus exposing the patients not only to the noises of the streets, but to the dust which will easily rise to the height of the first story.

Were it contemplated to erect instead four wings of the same size of foundation, each eight stories high, it is plain that the distance from the surrounding streets could be increased to such an extent that by proper planting of trees and shrubs the air would be so thoroughly filtered by the time it reached the buildings that it would be practically dust free. This would be true especially of the upper floors, but even the first floor would be greatly removed from the dust and noise to which a great portion of all the patients are exposed under the present idea.

Location. The location of hospitals is determined in the same manner. It is chosen because it is cheap; because some philanthropic person has donated it to the committee; because some influential member wishes to dispose of a particular piece of property; because it is in the vicinity of some medical college or some selfish member of the medical staff desires the hospital convenient to his residence in a large proportion of cases; and only rarely because it is especially suited for a hospital site. In the smaller towns very bad locations are usually selected in all cases in which the advice of location is left with the physicians, as from lack of experience they imagine that the hospital will be more prosperous if located near the business center of the town. They also have the foolish idea that the hospital must be within a few blocks of their offices or residences in order that they may readily be available in cases of emergencies, forgetting that emergencies are an unimportant factor and rarely occur during office hours.

There are certain fundamental principles which should be borne in mind



SECOND-FLOOR PLAN
REGINA GENERAL HOSPITAL
REGINA, SASK.

(By courtesy of M. J. Sturm, hospital architect.)

This plan shows a very convenient general hospital with elevator and conveniences in the middle of the building, so that these may be reached by the nurses with the slightest amount of walking in caring for the patients in all parts of the building. In this plan all of the stacks in the plumbing are so arranged that they can be readily inspected and repaired without annoyance in the conduct of the hospital. In this building the elevator should extend to the roof, which should contain a central portion with dressing-rooms, service-rooms, bath and toilet-rooms, and the remainder of the roof should be arranged for out-of-door sleeping space.

in the selection of a site for a hospital, no matter whether it be located in a great city or a country town. Of course all conditions are only relative. It is but rarely possible to obtain the ideal in the selection of a site, which has indeed been practically obtained in a few instances, of which we mention that of the Royal Victoria Hospital, in Montreal, but it is possible in every city or town to approximate these conditions much more closely than has been done in ninety per cent. of all hospitals. It should be stated here that this criticism applies to a much less extent to institutions conducted by sisterhoods than any others, as their selection of sites has in many cases been based upon recognized principles.

Absence of noise. The site should be in a quiet portion of the city or town, away from noisy railroad tracks, street cars or elevated railroads, or factories. In country towns this may be accomplished easily, and in great cities the location can be chosen at least three blocks away from ordinary railroad tracks.

(Nine-tenths of all of the larger hospitals of Chicago are located directly upon one or two street car tracks or within two blocks of an ordinary railroad track.)

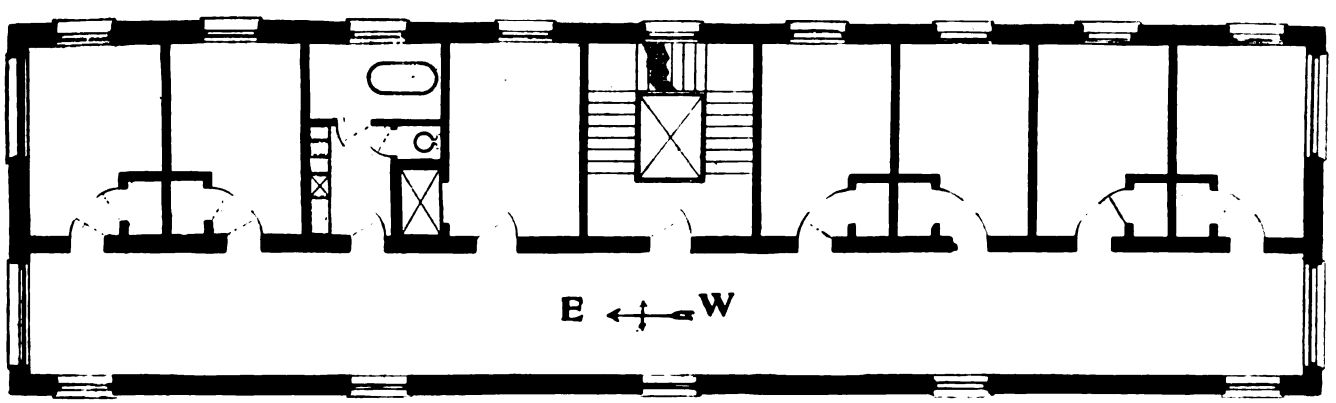
Absence of dust. Its location should be so chosen as to reduce exposure to street dust to a minimum. This can best be accomplished by selecting a high knoll in a hilly town, or by setting the building back from the street a considerable distance in a flat city and planting trees and shrubs which will act as natural filters along the edge of the grounds along the streets, and by erecting high buildings. Very little street dust relatively, rises above the second story, so that the higher stories are nearly free from this contamination. In every city there are streets that are comparatively little used. This fact should be considered favorably in the selection of a hospital site.

Sunlight. It is so extremely simple to plan a building so that every room and ward will have sunlight during some portion of the day that it is surprising to find many hospital buildings in which one-third or more of the rooms never have a ray of sunlight.

In order to have sunlight in each room and ward it is necessary only to construct all buildings or pavilions from north to south, which will give to one long side sunlight in the morning and to the other side in the afternoon.

The importance of sunlight, its distribution, the production and depth of shadows, together with the bearing this subject has upon the planning of hospitals, has been studied and illustrated with great care by Wm. Atkinson, architect (*Brickbuilder*, July, 1903). The various shapes of wings have been thoroughly discussed, with a careful consideration of the amount of sunlight and shadow obtained by buildings of the various forms usually employed. This feature has received careful attention in the work on the *Organization, Construction and Management of Hospitals* (Ochsner and Sturm).

At this point it may be well to direct attention to the fact that in long wings with a central hall, with wards or rooms arranged on either side of such hall, two outside and two inside walls will house as many patients as four outside and two inside walls would were the wards or rooms arranged along one outside wall and a hall placed along the other outside wall, and separated from the wards or rooms by an inside partition. This is plainly illustrated in figures shown, which represent two typical plans. The first shows a hospital extending from north to south in which every room or ward is exposed to sunlight either in the forenoon or afternoon, and the hall during midday. The next represents a building extending from east to west, with all of the rooms and wards exposed to the sun from the south and with a hall extending along the northern wall.



(From *Organization, Construction, and Management of Hospitals*, Ochsner and Strum.)

This represents a very expensive form of hospital, extending from east to west, with all of the rooms facing south. This form of building was very popular some years ago, but it has now been wisely abandoned in most communities.

It is plain that the expense of constructing a hospital for a given number of beds must be at least sixty per cent. greater if the latter is followed than with the former, because the additional walls amount to fifty per cent., and there will be required double the amount of outside walls which are, of course, much more expensive. Moreover the same area of hall space serves twice the number of beds in No. 1 that it serves in No. 2.

But this is not all; the distance of travel required by those employed in caring for the sick is just doubled. The area of the hall which must be kept clean is twice as great. The number of windows which must be kept clean is approximately twice as great.

Aside from this there is the disadvantage in plan 2 from the fact that twice the surface of outside wall is exposed to the weather and twice the amount of hall space must be heated.

Against this we have the fact that in plan 2 every room is exposed to the south. In most climates it is likely that exposure to sunlight for half the day is equally satisfactory in all except the summer season, and to be preferred in this season.

It seems plain consequently that plan No. 1 is much to be preferred.

Freedom from smoke. In many of our great cities there are locations in which there is but rarely any sunshine because of the presence of coal smoke from large furnaces and factories. These locations should of course be avoided in selecting hospital sites.

It is well to note the general direction of winds and to bear in mind the fact that smoke, although very diffusible in the air, will not be distributed to any considerable extent against even the slightest current in the air. It is also important to bear in mind that when the air is apparently still it nevertheless travels at a rate of about one hundred feet per minute, or about as one would move in sauntering along the street, taking a step in two seconds.

Again, in protecting the institution against smoke from any given source one may obtain a fair idea of the entire amount that will be delivered to an institution in still air by taking the distance from that source as the radius of a circle of which the segment corresponding to the length of the institution indicates the relative proportion of the smoke carried to this distance which will be delivered to the institution.

This illustration is employed to show how little of the entire volume of smoke will be delivered to any given space which may be occupied by the hospital in still air, and if the location is wisely chosen with this point in view it is usually possible to have the hospital on the windward side of the sources of especially great smoke producers during the prevailing winds, and thus the smoke nuisance will not be so much of an annoyance as one might expect. Fortunately smoke is usually produced in certain centers so that one may practically avoid them to a very considerable extent, by the careful selection of the site.

Accessibility. Without disregarding the principles already mentioned it is important that hospitals should be accessible to patients, to their friends, and to the officers of the hospital staff. This is important because it is not well for many acute cases, such as pneumonia, typhoid fever, peritonitis, etc., to be transported a great distance. Since the introduction of properly constructed ambulances in which the stretchers are suspended from the roof upon spiral springs, and in which the wheels are provided with rubber tires, the objection to transportation for a distance of several miles has very little real weight, provided the ambulance service is properly organized. With modern automobile ambulances a distance of ten miles is really of no importance if the roads are good. In large cities ambulances should be built so that

the wheels can run on street car rails, which will make the selection of smooth roads always possible.

Great distances are a hardship to the friends of patients who belong to the working classes, because of the time and expense involved in visiting such hospitals, and although it is usually better for the patient if his visitors are few, still the fact that it is difficult for friends to reach a distant hospital frequently serves as a sufficient ground for them to prevent patients who could be best treated in a hospital from availing themselves of this blessing.

Great distance also often prevents physicians and surgeons of the greatest learning and skill from serving upon a hospital staff, as the time spent in going to and from the hospital seems too great in proportion to the time spent in actual work therein. But since the adoption of automobiles has become so general, this objection no longer requires consideration, except in very cold climates where their use is not profitable during the winter months.

Hospitals should be located in residence districts of cities and towns, as the same conditions which make a location desirable for residence, make it favorable for a hospital. The nearer such a site is to a park, a lake, the high banks of a river, or the seashore, the better.

Size of grounds. It is of the greatest importance to have a good-sized area of land, as this will prevent the contamination of the air by immediate neighbors. It will make a free sweep of air possible. The buildings can be set back on the grounds so as to sufficiently secure some of the conditions mentioned above.

A hospital should never be placed between a number of large buildings in the middle of a block—a position too frequently chosen at the present time.

Even in the smaller villages one frequently finds hospitals almost completely filling the grounds. It is practically always possible to secure at least five acres of land for hospital grounds, as in most communities this land is not subject to taxation, and it is always a good investment.

Buildings. Having chosen a suitable location the question of planning the buildings themselves must be considered.

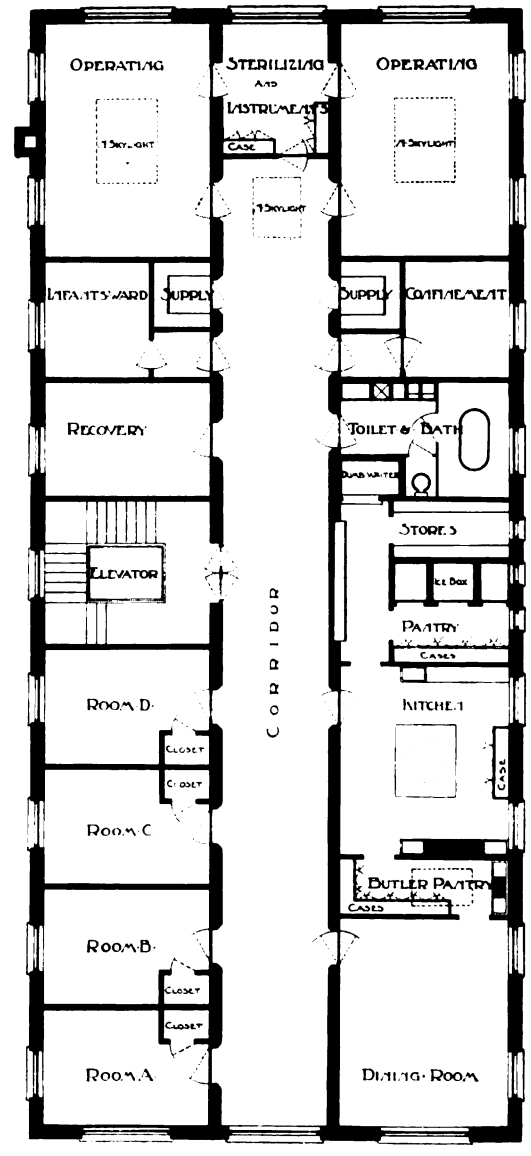
Forty years ago the theory of isolation of all portions of hospitals from all other portions received special favor owing to the views then held regarding contamination and infection. It was supposed that an ideal condition would be established if each patient could occupy a separate building supplied with all conveniences.

As this was not practicable it resulted in the planning of hospitals composed of numerous small separate buildings, usually one or two stories in height. There developed a fear of scattering disease from one patient to another through the medium of air contamination. Singularly enough this view was due to the fact that the real cause of contagion had not as yet been established and it was simply known that some diseases were transmissible from patient to patient. It was not then known that definite organisms must be carried from one patient to the other in order to cause this transmission of certain diseases. It is plain that if those who cared for patients in one pavilion could not come in contact with patients in another pavilion, the latter would not be infected from the former.

In this manner a practical solution was found, although this had not been based upon a scientific knowledge of existing facts.

Although we know that there is a definite difference between diseases transmitted from patient to patient, and the very much larger class in which this is not possible, the fundamental idea underlying all hospital construction still centers about this theory of air contamination.

In reviewing recent literature on hospital construction one constantly finds a reiteration of this idea. The various authors seem to be impressed with the



A GYNECOLOGICAL & OBSTETRICAL HOSPITAL.

TOP FLOOR PLAN

SCALE 1/8" = 1'0"

This represents the top floor of a very convenient small hospital extending north and south. At the north end of the building are located two operating rooms with large north windows and large skylights and with an intervening sterilizing room. If the hospital is also to accommodate obstetrical patients, the next room on the east side may be used for obstetrical operations, otherwise it may be used as a recovery room. Directly to the north of the elevator the hall is divided into a north portion to be used in connection with the surgical service, and a south portion to be used in connection with kitchen and dining rooms. This partition is not shown in the figure.

A hospital built according to this plan has been in operation for several years and is eminently satisfactory.

danger of the communication of disease from one patient to another, even in non-contagious and non-infectious diseases, and this is an idea expressed not only by architects whose ignorance in this direction would be excusable, but also by members of the medical profession. And yet when one asks hospital physicians of large experience for an example of such an occurrence among the thousands of cases observed one finds that no such instances have happened in the actual experience of those with vast practice.

The knowledge of this fact should make it plain that there should in the first place be a definite isolation of all cases whose disease can be transmitted by contact or by infection, and on the other hand that the other cases should be placed in buildings constructed with a view to securing conditions favorable to the treatment of the diseases involved, and not with a view of securing a degree of isolation which in this very large class is of absolutely no value, but of very great inconvenience and expense.

These patients need an abundance of clean air, sunlight, proper food and excellent nursing in clean rooms, properly heated, and as little disturbed by noises as possible. They should also be protected against danger from fire.

All of these requirements should be secured at as slight an expense as possible, as all available funds can always be employed with benefit even though no money be expended unnecessarily. The follies which have been committed in the way of obtaining a very slight amount of benefit to the patients for the amount of money expended are extraordinary.

It is necessary to study the expense, 1st, from the standpoint of primary cost of construction, and 2nd, from the standpoint of cost of maintenance.

In constructing buildings to house a given number of patients the first and the last stories are always of the greatest expense, as the first story implies the cost of a foundation with its system of drains for the proper disposition of the sewage. The last story is again expensive because of the necessity of covering it with a suitable roof.

These items may be divided into units of cost where the foundation proper (footings) are taken as one, the cellar or foundation walls as one and the first story as one, the superstructure (roof, walls, etc.) as one. This makes a total of four units for the first story covered, or for a one story building. Each additional story between the first three and the last is an added unit, so that in a six story building we have the original four plus the five added stories, making nine as against twenty-four units for six pavilions of the same area. This will be found to be a fair proportion.

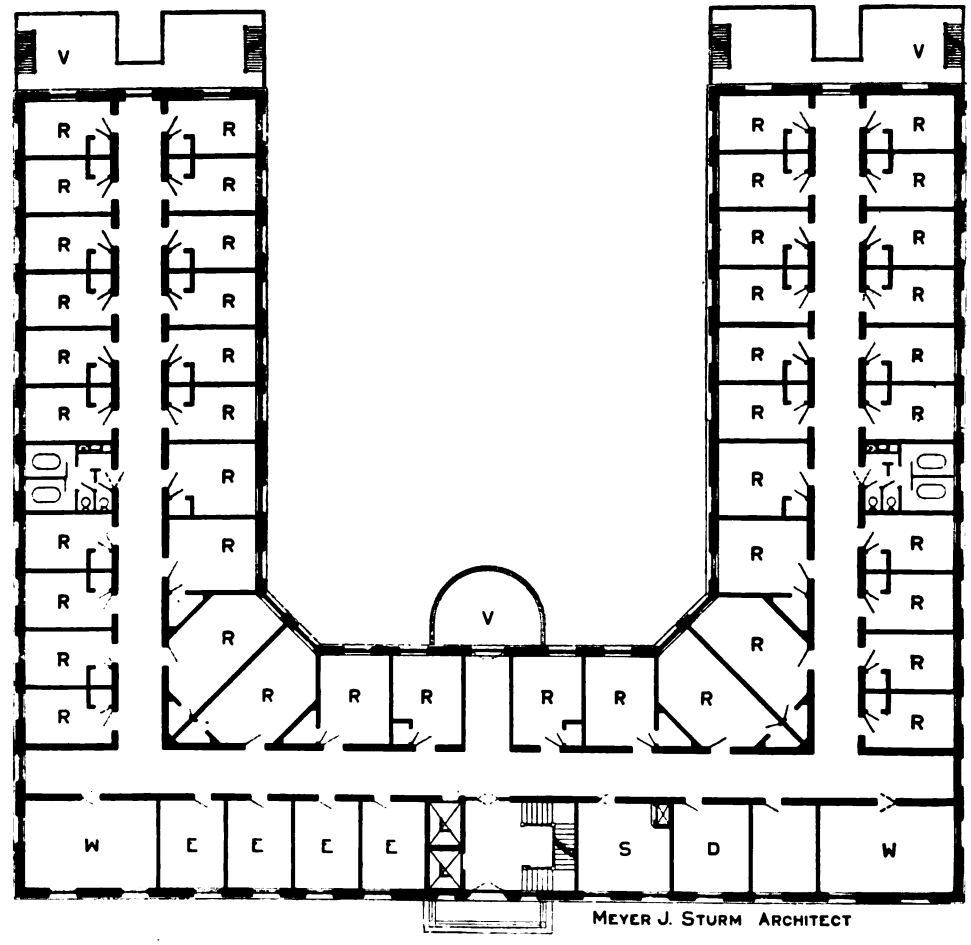
The intermediate stories require no foundation, the same sewer system which serves the first story can be made to serve all of the succeeding stories, and the roof covering the last story will serve all the intervening ones. The only difference lies in the strength of the foundation and the thickness of the walls, which must be proportionate to the height of the building.

It is also absolutely necessary that a high building be supplied with an elevator, and that its construction be thoroughly fire-proof, both conditions not required in a one-story building. But nevertheless the cost of construction of one of these high buildings is much less in proportion to the number of patients housed than that of one-story buildings.

It will readily be seen that the primary cost and maintenance of the plant will be greater in one story pavilion hospitals than in superimposed stories, as in the latter the system is simpler in construction, more direct and so more economical in all ways. This holds especially also for the plumbing, as the superimposed bath-rooms, etc., need but one stack and vent for each separate tier and can be run more advantageously. Again in the heating of these buildings the amount of heat wasted in cold weather is much greater in one-story

buildings because of the relatively greater amount of surface exposed to the outer air.

The difference in cost of construction between fireproof and non-fireproof is decreasing constantly especially so since many of the new so-called



(From *Organization, Construction, and Management of Hospitals,* Ochsner and Sturm.)

Represents one floor of a U-shaped hospital of many stories, which combines great convenience, perfect arrangement for sunlight, economy in conduct, service, heating, and lighting. It is an ideal plan for a hospital for large cities in which excellence of service and economy in cost of construction, cost of upkeep, and cost of maintenance are important elements. R represents rooms, W small private wards, E rooms for eye patients, S service room, D dressing and examining room, T toilet, L elevator, V veranda. By removing the partitions between two or more of the rooms R, wards may be arranged of any desirable size. All rooms except those used for eye patients have sunlight during some part of the day.

"armored concrete" constructions have been brought forward. Some of these are the equal of any construction known and cost but little if any more than first-class frame construction in larger buildings. This is more evident since wood has become scarce and correspondingly costly in the last few years. This is of very great importance as it makes it possible to obtain the advantages of housing the patients in a high building away from the noise and dust of the

streets and the dampness of the soil, without exposing them to the dangers from fire and without increasing the cost of construction to an unreasonable amount.

The use of the modern elevator and the automatic dumb-waiter makes it possible to care for patients in a building of a number of stories at a much smaller expense than when housed in a number of separate cottages.

There is one great danger in the adoption of high buildings for hospitals in the fact that there is a great temptation to decrease the area of the land upon which the hospital is built, while increasing the height of the building. This would, of course, be a fatal error as it would destroy the advantages to be gained from high buildings, especially if the neighboring buildings were also high.

The nearest building should be twice the distance of its height away from the hospital in order that there be no serious interference with sunlight and with the air supply. It is important in designing hospitals to arrange a flat roof properly planned to serve for an out-door sleeping pavilion. In this way the best possible facilities can be obtained for patients to recover from anesthesia after operations and for the care of other patients who are best off in the open air. Of course, the elevator and all other utilities must be provided.

Shape of the building—ground plan. Much attention has been given to the perfection of ideal ground-plans for hospital buildings. William Atkinson states the principles to be observed in the following concise manner: "First. To secure a large amount of sunlight for each building. Second. To impede as little as possible the circulation of air in and about the building. Third. To provide for the future enlargement of the hospital. Fourth. To promote convenience and economy of administration."

It is plain, that with a building a number of stories high, all of these fundamental principles may be solved in the simplest possible manner.

First. A building constructed on the general plan indicated in plan 1 furnishes a large amount of sunlight for every room or ward, as well as for the hall. It is important, however, that the hall extend the entire length of the building and that it be not obstructed by end-rooms or projecting walls at any point in its extent. It is best to construct the end of the hall almost entirely of windows and large glass doors by means of which patients can be wheeled onto the porches.

Second. The higher the building the less will be the obstruction to the air.

Third. Future enlargement may be accomplished by adding more stories, provided the foundation is built sufficiently heavy to permit this.

Fourth. Being compact it must be convenient and economical to manage.

The same author gives a sun plan of the various typical forms which may be given to a ground plan, illustrating with excellent diagrams the amount of sunlight as well as the extent and the depth of shadows produced by each form.

A study of the diagrams will convince any one that the form indicated in the plans shown contains the greatest number of advantages. This plan can be carried out by simply building a single pavilion as shown, or two or more of these pavilions may be built in a row with a sufficient space between.

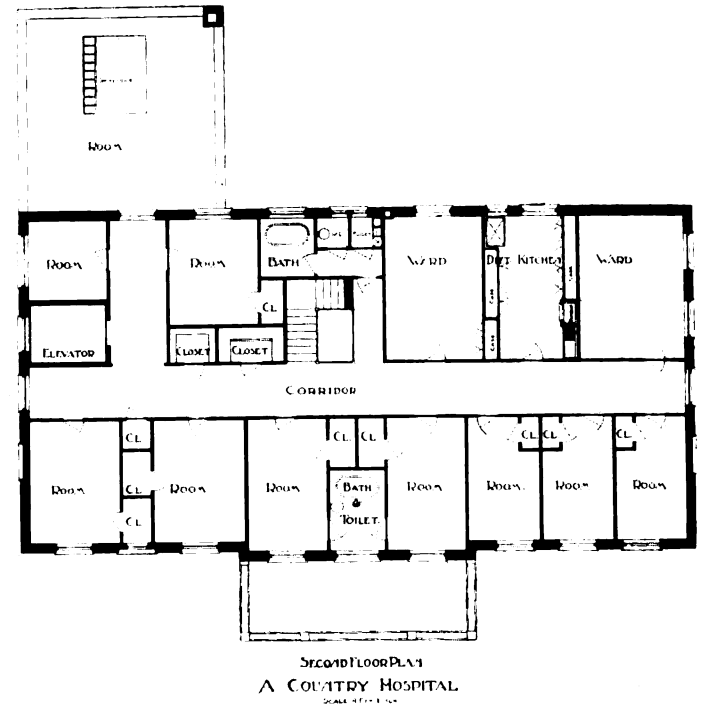
These plans may all be united by a one story corridor, or building, which should preferably be placed at the north of the pavilions in order not to throw a shadow upon the land between the various pavilions. In this way another means of enlarging the institution by adding further pavilions may be provided.

Or they may be placed in the form shown herewith, the open court facing south, or better still, a little east or west of south. Next cut gives a plan of

a small country hospital which represents the same principle. This building must of course also extend from north to south.

In large institutions for the care of the sick in great cities it is well to consider a ground plan, as next shown, in which one wing or tier of pavilions is intended for male, the other for female, patients, the administration building being placed between these two wings at an equal distance from each.

Aside from providing for the housing of the patients it is necessary to make provision for the housing of the officers of the institution, the resident medical staff, the nurses and the servants. Provision must also be made for



(By courtesy of M. J. Sturm, hospital architect.)

We have here a small hospital for a small country town. The building extends north and south, and thus supplies sunlight for all rooms and for the hall, which must have large glass doors at each end. The building may be built one, two, or three stories high. It has all facilities of the modern city hospital.

the administrative offices, for the kitchen, laundry and boilers supplying heat and steam power.

If but a single, many-storied building is chosen it is well to place the offices in the first floor, as well as the rooms for the house staff, the drug room, laboratories and the examining rooms, as this places the patients in the higher stories where they are away from the disturbances naturally occurring on the first floor.

It is usually better to house the servants and nurses in a separate building, so as to compel them to be away from the hospital proper during their time of rest.

It is, however, often more convenient to build the original hospital build-

ing sufficiently large to house the patients as well as the servants and nurses at first, and as the latter space is required for patients, to then prepare separate quarters for the nurses and servants.

Kitchen. In such a building the kitchen should be in the top story, connected with all the stories by means of a dumb-waiter, each story having besides its own diet kitchen and nurses' room. This prevents the annoyance which invariably exists from the odors of cooking when the kitchen is in any other portion of the building. During the past few years more effective methods of ventilation for kitchens have been introduced, so that it is now permissible to place kitchen, dining-rooms and storerooms in the basement, provided this is high and light and properly constructed. This feature is well worth while considering, because of its convenience and economy.

Operating rooms. The operating rooms should also be in the uppermost story in order to secure the air freest from dust and to prevent annoyance of the other patients during operations, and so the principal light for operating may be obtained through north skylights.

Recovery rooms. It is well to provide a number of rooms in this story in which patients may be kept twenty-four hours, or longer, after the operations, so as to prevent the disturbance of other patients in the hospital by those who have just been operated.

In this manner all of the business of the hospital at all likely to disturb patients is conducted in the first and last stories of the building, as far as possible away from the inmates.

Heating. The problem of heating depends largely upon the climate in which the hospital is located. In most cities in this country it is necessary to provide efficient means of heating hospitals during the cold season of the year.

The most economical form of heating in the colder portions of this country is by direct radiation from steam coils, in the warmer portions of the country from hot water coils.

There is no doubt but that air which has come directly in contact with steam coils heated to 212° F. is not nearly as wholesome as that which has not been exposed to so high a degree of heat. With the ordinary steam coil there is, however, only a small proportion of the air contained in a room which comes directly in contact with the coils. The greater portion of the entire amount of the air in a room being heated by contact with air nearer the coil which has been heated, consequently only a portion of the air is spoiled by being overheated by this system.

All systems of combined heating and ventilation by means of indirect heat with forced ventilation are extremely expensive and very unsatisfactory and should be absolutely condemned in hospital construction.

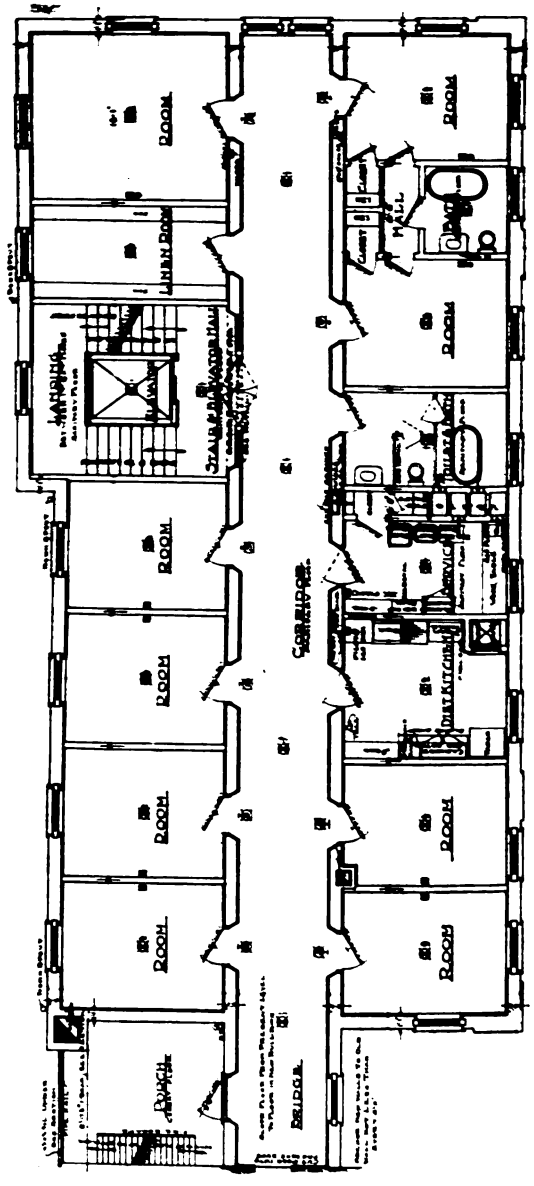
Ventilation. The question of ventilation is usually discussed in connection with heating, because in cold weather the fresh air brought into a room must first be heated in some manner before being delivered to the patient.

In natural ventilation, which occurs through the walls of the buildings, or through cracks about the doors and windows, the cold air entering is heated by coming in contact with the air already in the room.

Artificial ventilation. In artificial ventilation there are still many practical problems which have not been definitely settled.

This kind of ventilation may be accomplished by removing the air in the room by means of fans, or through heated flues in which a draft is caused by the fact that hot air rises, because of its decrease in weight, due to expansion.

The space occupied by the air removed from a room by either of these methods will be filled with air coming from without, either through openings



(By courtesy of M. J. Sturm, hospital architect.)

Small hospital extending from north to south, so arranged that its capacity can be increased by lengthening the building to the south. At the southwest corner two private rooms are shown with a bath between them, which is an excellent arrangement for the accommodation of the better classes of private patients. The arrangement of general bath-room, service-room, and diet-kitchen is most complete and convenient in this plan and still economical in the use of space.

provided at points at which the cold air has to pass over heated radiators, or through a main duct above the roof, and necessary heating coils below the same to a settling chamber, and then by smaller ducts to the various rooms.

Another method consists in forcing air by the use of fans through a chamber heated by coils, thence through flues into the various rooms and wards. This plan may be employed alone or in combination with the methods just mentioned, by means of which the bad air is drawn out of the rooms. But this method has among its leading drawbacks this, that a constant temperature cannot be maintained, owing to external and internal variations and conditions.

(There are always air spaces which contain air that can be displaced only with difficulty, while there are other spaces in which the air can be changed easily, consequently the fresh air will constantly be forced into spaces which are least in need of a change, while other portions of the room will continue to contain vitiated air.)

If this plan is chosen, it is important to take the air from a high point and never from the level of the ground, because in this manner air relatively free from dust and moisture of the soil may be obtained.

It is, however, important that the intake be at a point where the air is not vitiated by the bad air forced out of the building, or by smoke from the chimneys, or sewer gas from the soil pipes which project beyond the roof. This may be accomplished by placing the intake to the windward side of the building during the cold season of the year, for it is during such season that the forced ventilation will be in use.

The heat chamber through which the air is forced should be supplied with hot water pipes in which the heat is regulated so as not to exceed 160° F., as air blown over pipes heated with steam to 212° F., loses much of the invigorating effect obtainable from fresh air.

Theoretically it has seemed that a system which combines the plan of withdrawing the vitiated air from the rooms by means of a system of tubes, and fans which force into the rooms at the same time a sufficient amount of air taken from a point at which it is most likely to be pure, would result in the best possible conditions.

In many buildings, not only all of the air, but all of the heat has been supplied in this manner, the air being heated sufficiently in passing over the coils in the hot air chamber to supply the necessary heat.

The great advantage in this system comes from the fact that in order to secure a sufficient amount of heat a great amount of fresh air will have to be supplied, and in this manner the ventilation must necessarily be excellent during the cold season. The amount of heat supplied to each room can be automatically determined.

There are four important objections to this system. 1. The principal reason for rejecting this method lies in the fact that very large ducts and outlet surfaces must be provided, a condition of things which is practically almost impossible in the economic arrangements of a hospital. Smaller ducts and outlets would not be practicable owing to the velocity of the ingress and egress of air necessary to give both heat and air sufficient to do the work. 2. The expense of maintaining it is very great. 3. If the coils are heated by steam the air loses much of its invigorating effect because a great portion is actually overheated. 4. In autumn and spring it is almost impossible to supply a sufficient amount of air to each room without overheating it unless hot water coils are used which are regulated so that their temperature does not exceed 120° F. during the autumn and spring, while later it is raised to 160° F., and as the air passes over the coils more slowly a greater relative proportion of it comes in direct contact with the coils and is consequently more thoroughly spoiled than in winter. Moreover, in winter when

large quantities of cold air are blown over the coils the surface of the latter never quite reaches the temperature of the steam contained within, and this in turn prevents the air from being spoiled by overheating.

Whether it would be possible to supply a sufficient amount of heat in very cold weather if the hot air chamber were heated by hot water coils at a temperature not to exceed 160° F. we cannot state because so far as we have been able to learn this plan has not as yet received a practical test. That this would greatly improve the quality of the warm air there can be no doubt.

It would consequently seem best to supply only the fresh air for ventilation heated in such a chamber while the heat for heating the building would be supplied by direct radiation.

This would at once be economically and hygienically correct. In the spring and autumn when only a very small amount of heat is required it would not be necessary to use the steam radiators as a sufficient amount of heat could be supplied with the ventilation.

In buildings in which the air passes over coils heated with steam the atmosphere is most depressing during the months when little heat is required, as the volume of fresh air forced into the rooms is smaller than during the coldest season, hence a greater portion comes in contact with the overheated coils, and the surface of these coils is of a higher temperature than when a large amount of cold air is forced over the coils, hence there is not only less air, but the air is of a poorer quality.

During the warm season of the year when no artificial heat is required, open windows and straight corridors are of the greatest importance, as well as careful grouping whenever several buildings are constructed, to prevent obstruction to currents of air.

In this again the higher the building the freer will be the currents of air, because of the fact that there must necessarily be less obstruction from surrounding structures and hence the natural ventilation must be better.

A very important point in ventilation of hospitals during the summer months lies in the fact that in high buildings there is always a marked difference in temperature on the outer surfaces of the building, which naturally constantly causes a current of air through the corridors of the hospital, providing they pass through the building.

Filtering of air. The best methods of cleansing air are the natural ones. Air which has been carried across a large body of water is practically free from impurities, because these have fallen into the water. Air near the tops of high mountains is pure because impurities fall to the ground before they are carried to these great heights. In tall buildings there are more microorganisms in the air entering from without in the lower than in the upper floors.

For these reasons it seems wise to obtain as large a piece of land as the means will permit, in the highest available location, and then construct the buildings as near the center of such area as possible. The higher the buildings, the better will be the chances of obtaining good air for the greatest number of patients.

Shrubs and trees planted between the building and the surrounding streets will serve to filter a considerable portion of the street dust out of the air before it reaches the building.

In forcing air into a building for the purpose of ventilation it is possible to select that which is relatively free from dust and impurities if the intake has its opening at a good height somewhere near the roof of the building, but in such a position that the prevailing winds will force the impurities which come from the chimneys and ventpipes away from the intake.

Many devices have been instituted for the purpose of washing the air which

is forced into a building by fans. Streams of water are permitted to drip over moist gauze or other substances so as to intercept the fine particles contained in the air. This treatment of the air has, however, not yet been fully and satisfactorily demonstrated, although many authorities speak well of it.

A method which has been used frequently by the government in some of its hospitals, and especially in its larger office buildings, is to heat the air above freezing point and then pass it through a wall of finely sprayed water, there being many of these small apartments about eighteen inches square so as to keep the water from spreading. This is economical as the water can be filtered and used over and over. The air is then sent into a drying room and from there into a space where a fine spray gives it the requisite moisture, the drying room being kept at a temperature so that the air goes out to the several ducts at slightly higher temperature than that of the rooms. The system has been found very satisfactory, exceedingly simple and inexpensive. In most cases, it is probably most satisfactory to use a system of exhaust fans which will exhaust the air from bath and toilet rooms and to force this out of the building, permitting the fresh air to enter from the outside in the natural way.

Lighting. Incandescent electric lights are probably the most cleanly, convenient and satisfactory in most cities. In large institutions requiring high pressure steam for other purposes, such as running elevators, pumps, laundry machinery, etc., electricity can be manufactured at a reasonable expense for lighting the building.

If the institution is dependent upon ordinary illuminating gas it is preferable to make use of some one of the various incandescent mantles in the market, as the quality of the light is thus greatly improved, while for the same amount of light the amount of carbon dioxide and smoke are greatly reduced in quantity, moreover it is much easier to regulate the amount of light.

In large institutions acetylene gas may be used economically. The quality of the light is excellent and with proper care the amount of smoke is very slight.

There is some danger of explosion if the apparatus is not handled by a careful person.

Plumbing. Plumbing in residence and hotel construction has been perfected to such a degree that if the same care is employed in the installment of hygienic plumbing in hospitals there is no reason for change or improvement, with the exception that special facilities are required for disposing of contents of bed-pans, etc. A large slop sink and hopper, with a water seal which will at once dilute any offensive matter thrown into it, has been constructed recently and is of great value. It is provided with syphon together with a large plunger which cleanses the entire contrivance thoroughly and at once.

Sterilizing rooms. Sterilizers for surgical dressings, sheets, towels, instruments, etc., are so perfect as supplied by many manufacturers that it is scarcely necessary to dwell upon them. Sterilizers for mattresses are not so satisfactory as yet.

Floors. In the halls, bathrooms, closets, kitchens, operating and dressing rooms, some form of flooring which is impermeable to moisture, such as tiling or glass, has been generally adopted with great satisfaction, as it may be easily kept clean and is attractive in appearance. The most satisfactory material is known as flake mosaic, especially if this is made in the form of large tiles. In the wards and rooms hardwood floors laid on the cement covering which isolates the floor from the lower story, seems preferable. This should be covered by some dressing impermeable to moisture in order to prevent

septic materials from penetrating the pores of the wood. A careful application of grain alcohol shellac closes the pores quite effectually.

The walls should be covered with paint, which prevents the plaster from becoming filled with germs. These walls may be washed and thus rendered aseptic after the rooms have been occupied by patients with suppurating wounds.

In the operating and dressing rooms walls covered with tile, marble, glazed brick or glass are very attractive, but they are in no way superior to those that have been carefully covered with hard enamel paint which is impervious and acid proof.

HOSPITAL MANAGEMENT

Concerning the internal management of hospitals there is much to be said, because at the present time no definite system has been established, except in hospitals under the control of sisterhoods that have conducted similar institutions for many years in the past.

In other American hospitals the management, as a rule, is the cause of almost unceasing annoyance to every one connected with the work. In time, no doubt, there will be developed as definite systems of management of hospitals as now exist in other departments of human activity. There are very definite plans for conducting almost all other enterprises. One would not expect to manage a railroad, bank, department store, saw-mill, or any other industry unless one had a definite knowledge of a system according to which such industries were commonly conducted with success, simply because it would not be possible to compete with those who have this knowledge.

It is quite different in the control of hospitals, because any deficit which may occur as the result of incompetent or bad management can readily be made up by contributions from those who are interested in these institutions as public charities. This is true to so great an extent that one almost invariably finds that the institutions which are worst managed are at the same time most generously supported.

Fortunately many of the smaller institutions have but little outside support and consequently their existence depends upon the ability of those in charge to develop a reasonable plan of management, and this condition must in time result in a recognized system which will ultimately become generally adopted.

For the management of smaller hospitals it will be necessary to have nurses educated in training schools not only to do scientific nursing, but also to perform all the other duties connected with the government of hospitals.

Fortunately several training schools for nurses have been organized during the past few years with this end in view, and a number of the older schools have added new departments of instruction in order to enable their pupils to become more broadly educated, with a view of making them more thoroughly competent to manage the great number of new hospitals which are springing up in all parts of this country.

If it is possible to obtain a trained nurse who is familiar with the details of the entire management of a hospital, it is usually best for all of the smaller institutions to vest the entire management of the institution in this office, i.e., the superintendent of nurses.

In order to be competent to occupy this position properly, it will, however, be necessary for the occupant not only to be an excellent nurse, but she must be a good housekeeper, a good business women, must know how to buy supplies, how to get on with little by economizing in every way. She must know how to select help and how to keep it. She must be a good teacher

in order to obtain satisfactory work from the pupil nurses. She must know how to act promptly and quietly in case of emergencies. She must do all of this cheerfully, lest she drive patients away from the hospital, and must consequently have an unlimited amount of good judgment and tact.

Above all things she must be absolutely reliable, and must be looked upon in that spirit by every one connected with the institution.

One quality which in the main depends upon good judgment and tact, but which is but rarely found in persons at the head of hospitals, is a willingness to do what can be done under existing circumstances, although it may not quite approach one's ideals, without grumbling over things which are for the time being uncontrollable.

A person who possesses this quality at once becomes a leader and will consequently accomplish vastly more in the end.

Many of the smaller hospitals owe their success, if not their continued existence, in a large measure to the fact that they were able to secure the services of such a person for the leading spirit in the management of the institution.

There are two items which it is important to bear in mind at this point.

It is important to plan the work so that this person has one entire day each week away from the institution, and some time during each day for rest without disturbance. One who has all of the most desirable qualities too often has not the wisdom to take the necessary rest to be able to continue this work to the fullest extent.

The other point is as regards the authority of such a person. She should not be hampered in any way.

It is here that the harmful effect of meddlesome committees of women's auxiliary boards so often make it impossible to develop a desirable system. In the few hours that a committee, composed of the most excellent ladies of the village or city, give to hospital matters each week they can usually perpetrate more follies than can be remedied during the remaining days by those who give their entire time and thought to the work.

No one who does not practically give all of his or her time to hospital work should have anything to say concerning the management of the institution, aside from auditing the accounts, and this should be done by an expert accountant whose only duty should consist in determining the correctness of the items.

The board of directors should be divided into various committees to which questions of importance should be referred; but no member of the board should in any way interfere in the conduct of the institution directly, because it is not at all likely that he will be in possession at any time of sufficient data to make his interference advantageous to the institution. Such interference would not be tolerated in any other business enterprise and still it is only too common in the management of hospitals.

It should be thoroughly understood that hospitals can be managed on precisely the same principles that one applies to any other successful business enterprise, and that the same principles will result in similar success. This has been demonstrated in a number of the most useful hospitals in this country, and only when this desideratum has become generally accepted and put into practice can we expect the greatest possible amount of benefit to come from these institutions.

All persons performing work in the hospital should be properly paid for their services, otherwise the service is certain to be very inefficient and the institution will be compelled to feed and house an army of incompetents who would not even be able to earn their board and lodging elsewhere.

The above tenet will make it proper to expect good work from every

one employed, and any one who fails to do his share of the work may be dismissed with justice to himself and benefit to the hospital.

Pupil nurses receive their tuition in the form of lectures, class work, recitations, laboratory work and bedside instruction, which should pay for their services in part or in whole. In the larger hospitals this is also true of the members of the resident medical and surgical staff.

The number of assistants, pupil nurses and servants necessary depends entirely upon the size of the hospital and the character of the work performed.

In an institution of less than thirty beds it will not be necessary to have a matron or housekeeper. In a larger hospital this will be necessary, but this position should be under that of superintendent of nurses. It is, however, a great advantage to the institution to have a matron who is also a graduate of a training school for nurses, because she will be much better able to comprehend the demands upon her department.

The other servants, such as cook, chamber-maids, laundress, janitor, as well as the number of pupil nurses, will depend upon the number of beds.

There are many other items which might be discussed in this connection, but what has been said above will suffice to make clear the most important principles involved in the organization and management of a hospital.

Supplies. In purchasing hospital furniture it is important to combine utility and durability with attractiveness, at the same time securing furniture which can easily be kept clean.

For a number of years hospital authorities have neglected to pay sufficient attention to the element of attractiveness so that the beds, for instance, remind one more of cots in a penitentiary than of beds for the use of sick human beings who need cheerful surroundings.

It is now possible to secure attractive hospital beds which are strong, easily cared for and easily kept clean.

The bed for surgical cases should be high so that the top of the mattress is seventy-five cm. from the floor. This makes the work very much easier for the nurses. The beds should be so built that either the upper or the lower end can readily be elevated. It is important to secure good springs for the bed.

The other articles of furniture, like bedside tables, wash stands, etc., should all be well made of plain but artistic pattern and so built that they can readily be kept clean.

The utensils furnished by hospital supply houses are so convenient and so well made that it is not necessary to describe them especially.

There should be a sterilizer on each floor so that all utensils may be sterilized regularly after they have been used.

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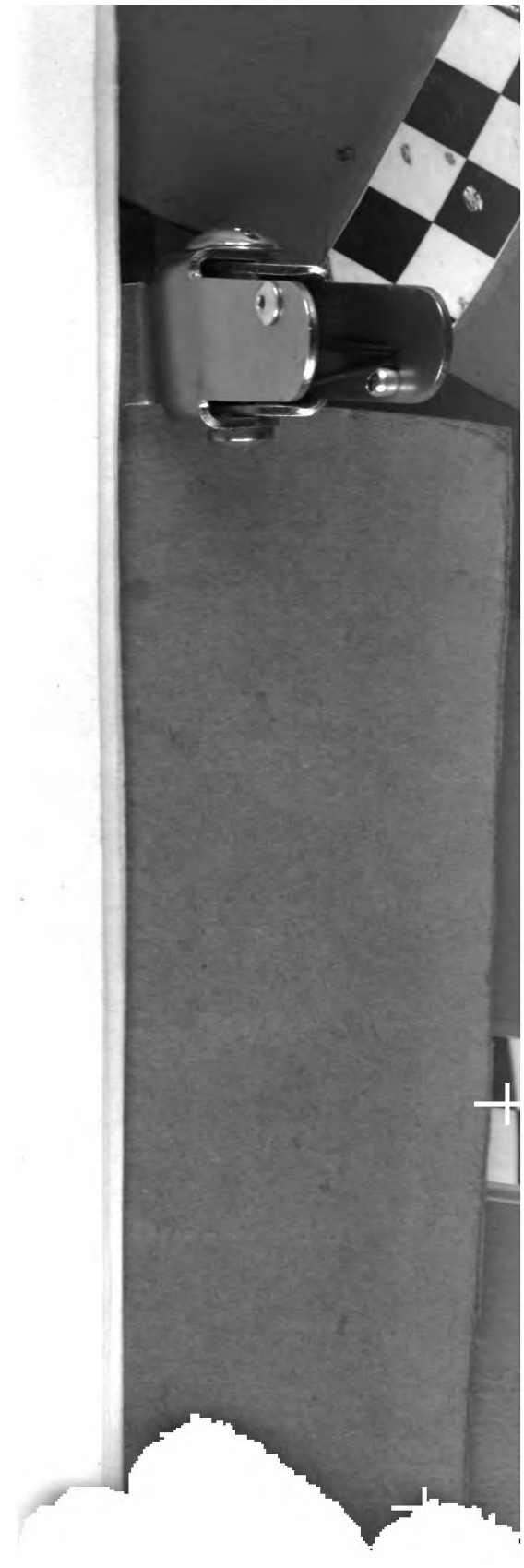

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